SOLO
User Manual
Version 5.15

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Appendix C - Firmware Settings   Error! Bookmark not defined.

Introduction

The **SOLO** Robotic Pipettor is designed to easily automate complex pipetting tasks that would otherwise prove tedious or error-prone for researchers to perform manually.

The **SOLO** can be controlled as a stand-alone instrument using its easy-to-learn user software, called **SOLOSoft**. Or, it can be integrated into larger automated systems using its own Active X control. Hudson's **SoftLinx** scheduling and workcell control software offers such an integrated interface.

In its standard configuration, the **SOLO** offers 4 plate nest positions, for locating labware such as microplates, disposable tip boxes, fluid reservoirs or other SBS-standard labware. Two additional locations can be added to either the left or right side of the **SOLO,** to allow a total of six nest locations. Mounted on the side is a flush station with a drain, upon which is mounted a forked fixture for removing disposable tips. An emergency E-Stop button is mounted on the front body of the **SOLO**. Pressing this immediately stops all motion of the major (X, Y, Z) axes and causes the normally blue pilot light, located on the upper arm, to turn red. While the E-Stop button is pressed in, arm power is removed from the major axes, allowing them to be manually moved by the user.

We currently carry three configurations of the **SOLO** chassis. The standard configuration includes a either a 125 uL or 250 uL capacity syringe that is mounted on the robot's vertical axis, offering individual pipetting volumes from 100 nL to 250 uL, and a waste station, and a tip-shucking station to automatically remove disposable pipette tips.

The second configuration, offers a syringe pump mounted on the rear vertical frame member, with either an 8 or 3 position valve. The syringe is mounted on the pump body and may be easily changed by the user to sizes ranging from 25uL to 10mL per full stroke. This configuration allows the **SOLO** to perform as both a Pipettor *and* Dispenser, drawing fluid from any one of up to 7 fluid reservoir bottles.

The Third configuration, offers either an 8 or 12 channel multitip dispenser. The 8 and 12 channel heads come in either 20ul or 200ul syringe capacity per channel configurations. The multitip head can be used as a multichannel or single channel dispenser.

The **SOLO** also offers an alternate configuration that allows it to become a component in Hudson's **LabLinx** track-based stacker system, providing automated feeding and removal of plates and/or tip boxes for high throughput applications. The **LabLinx** track mounts directly to the **SOLO**'s deck, taking the place of 2 plate-nest positions, or even all 4 if very high throughput is desired.

The **SOLOPlus** is a SOLO integrated with Hudson's **Micro10x** high speed bulk dispenser. The dispenser is attached to the side of the SOLO with provided hardware. The Micro10x and SOLO share a nest position and SOLOSoft seamlessly controls both instruments through its interface.

Section 1 – Hardware

1-Unpacking the SOLO

- Remove all material from inside the crate except for the SOLO itself.
- Cut the Black plastic strapping that secures the SOLO to the shipping form.

Shipping
Straps
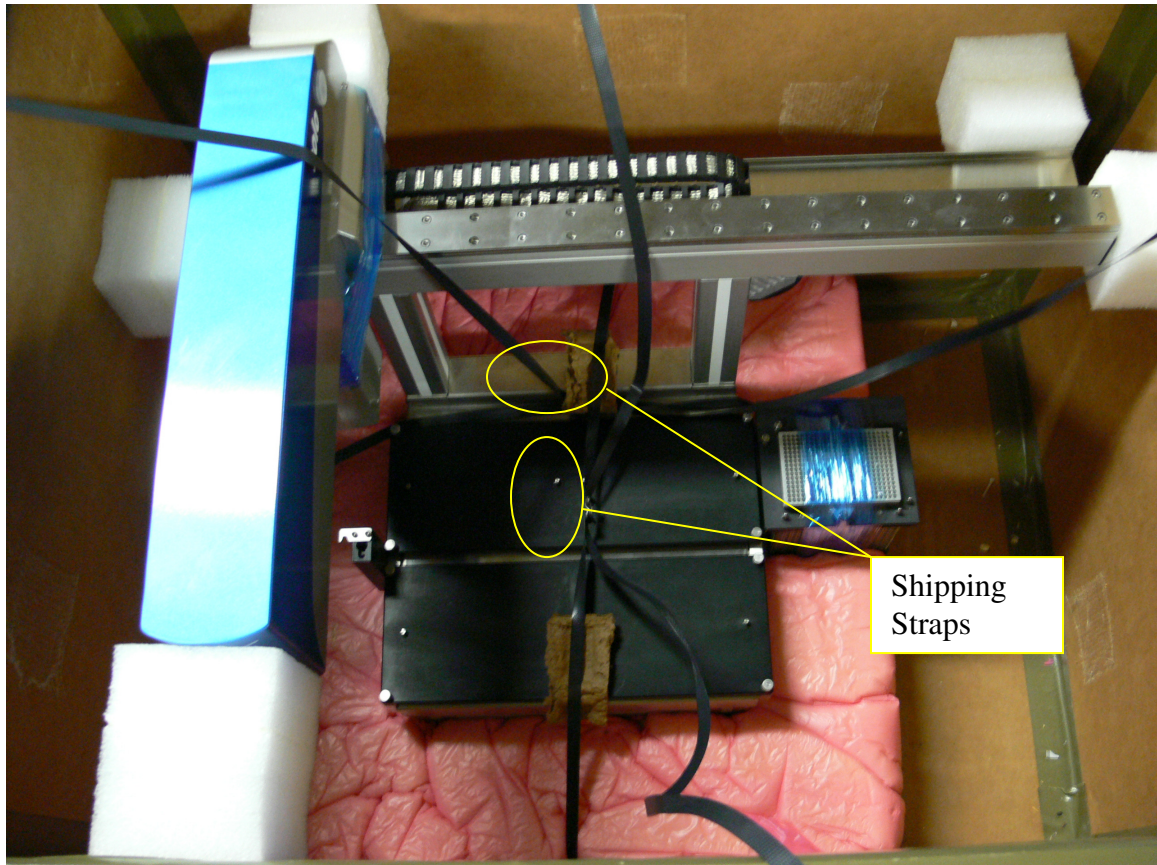
- Once the straps are removed lift the SOLO by the aluminum bracket that the nest plate holders are secured to. DO NOT LIFT BY THE ARM as this will damage the unit. See Picture on next page

Lifting points on Solo
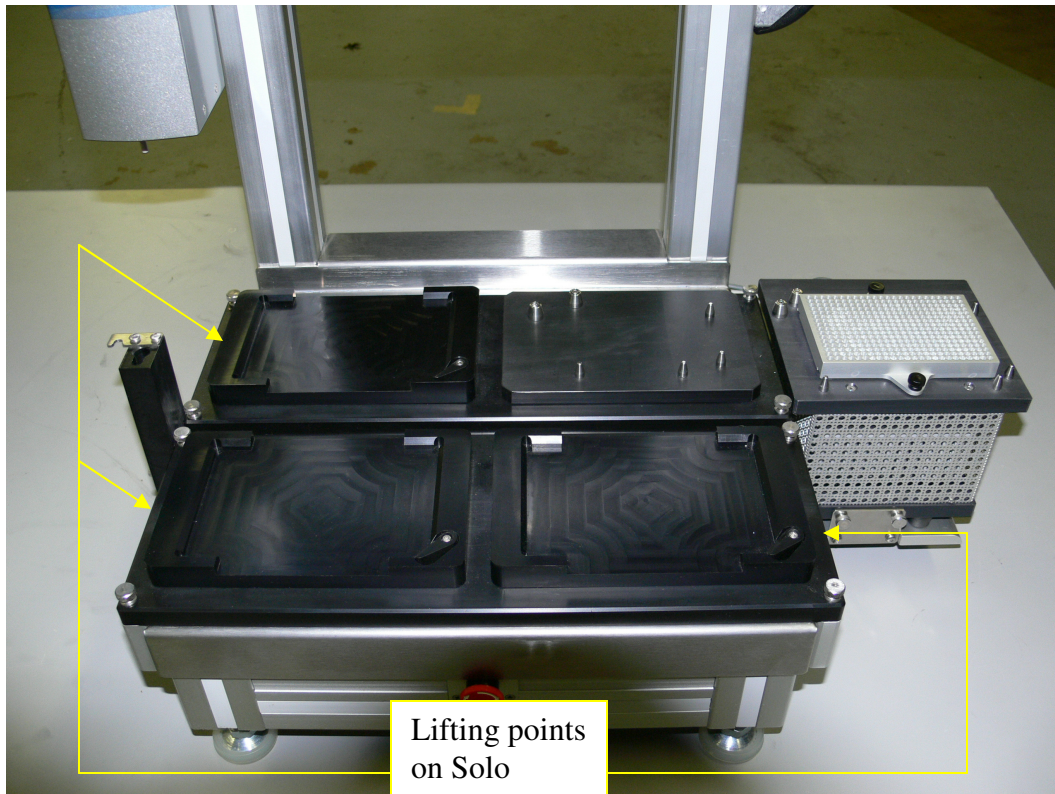
- Once the unit is out of the crate remove all the plastic wrapping that secures the arm to the SOLO and the cooling nest to its alignment bracket.

Remove Plastic Wrap
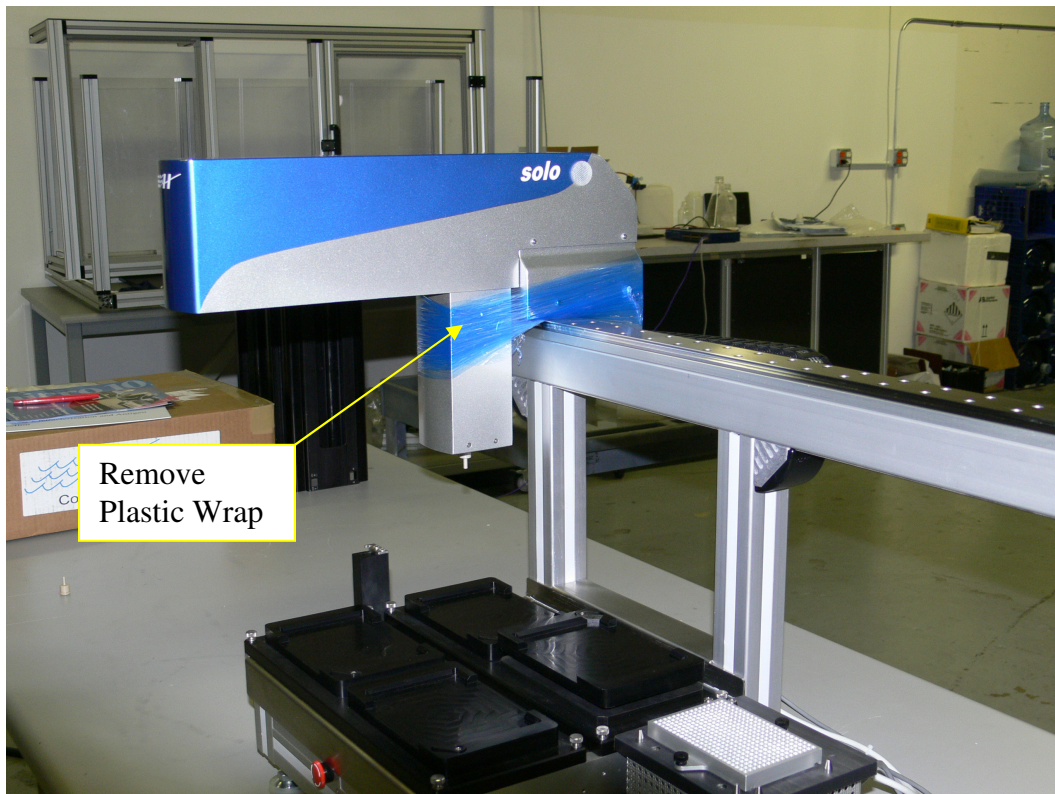
- Once the plastic wrap is removed install the nest plates on the deck of the SOLO. Align the holes in the bottom of the nest plate with the metal dowel pins on the stainless deck and push the nest plates onto the deck.
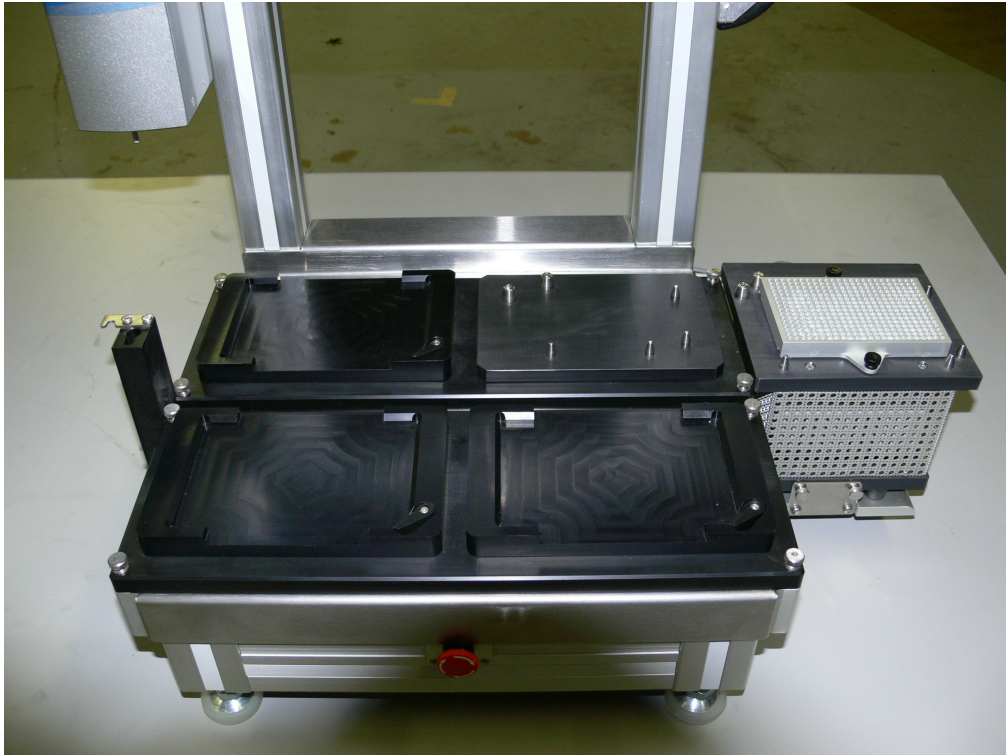
- Remove the Power cable and communication cable from their shipping packages and plug them into the correct locations on the SOLO's rear panel.
- Install the SOLOSoft on the computer you are going to use with the SOLO.
- The unit is now ready to startup.

2 – SOLO Setup

Depending on the version of SOLO that you purchased, there will be different hardware setups before you start using your instrument. We currently carry three types of SOLOs:
1-Ivek Pump (125ul or 250ul)
2-Hamilton Pump (syringe size optional)
3-MultiChannel (8 or 12 Channel configuration)

2.1 – Ivek Pump Setup

The Ivek Pump SOLO comes ready to run from the factory. The Mandrel is shipped on the unit, so there is no need to setup anything on the unit. (See Figure 2.1)

Unit ships with mandrel installed
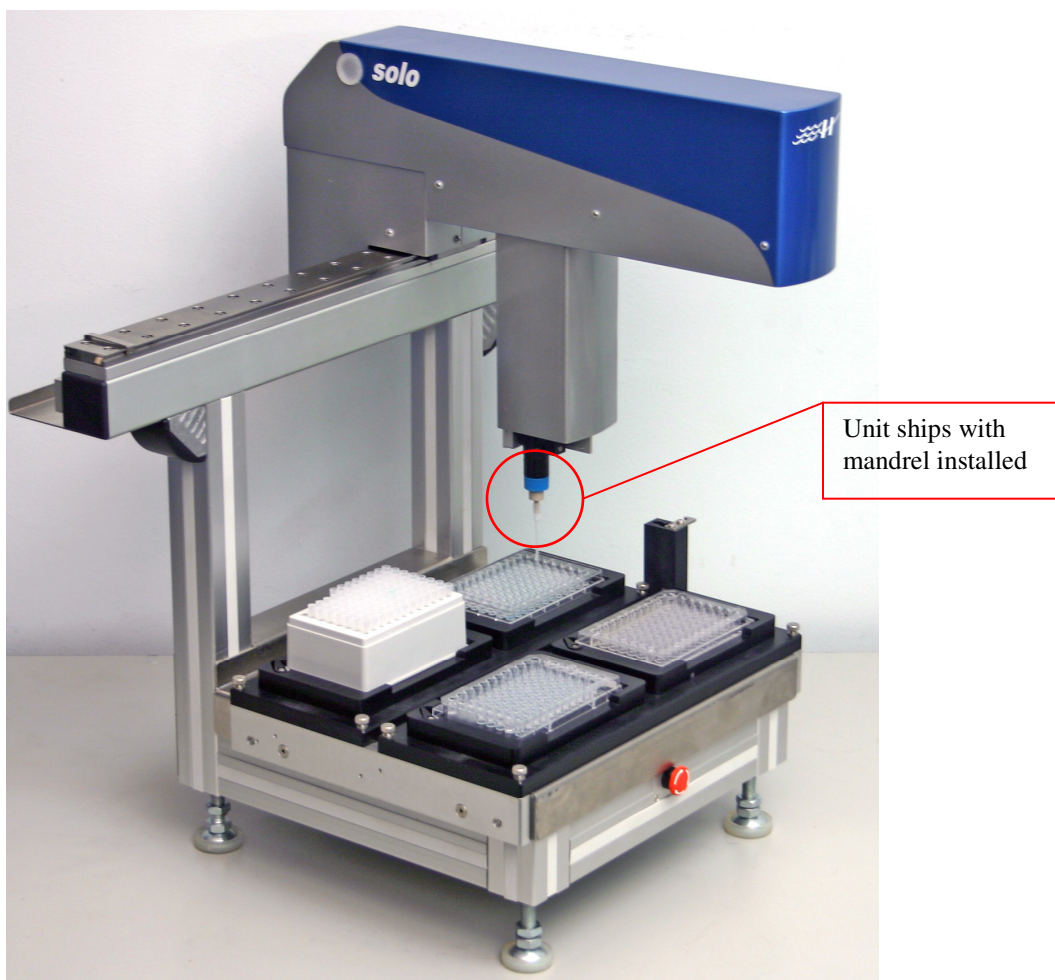
Figure 2.1

2.2 – Hamilton Pump

The Hamilton pump SOLO is disassembled during shipping to prevent damage. The glass syringe from the pump is removed before shipping. The mandrel for a disposable tip, or the fixed cannula tip, is also removed before shipping. You may need to home the unit first before you can reinstall the Glass syringe. The cannula tip mandrel is installed

be pulling out the plunger that locks the mandrel into the Z-axis assembly. (See Figure 2.2)
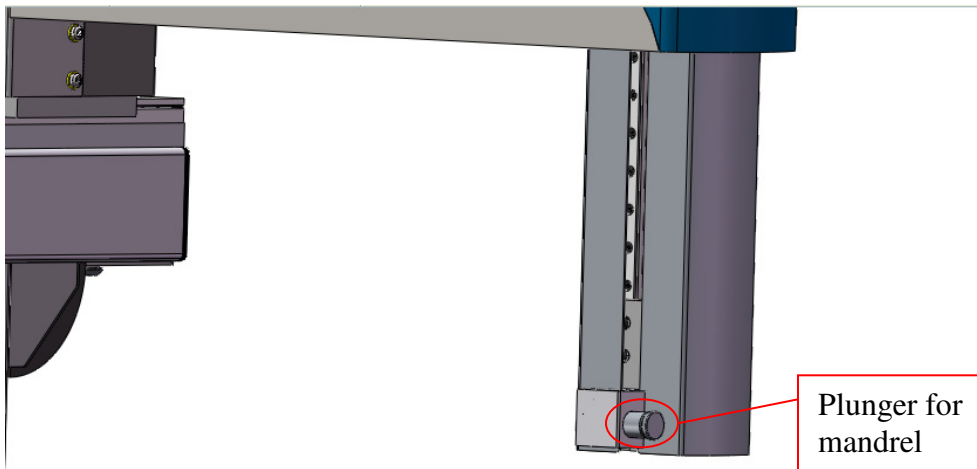
Figure 2.2

2.3 – Multichannel

The Multichannel SOLO is disassembled during shipping to prevent damage. The Multichannel head is removed for shipping. The Multichannel head is screwed onto the SOLO's z-axis. Screw the Multichannel head assembly onto the Pipettor drive assembly. (See Figure 2.3) You will do this by screwing the Blue threaded nut that is attached on top of the Multichannel head to the Threaded post on the Pipettor drive assembly. (See Figure 2.4)
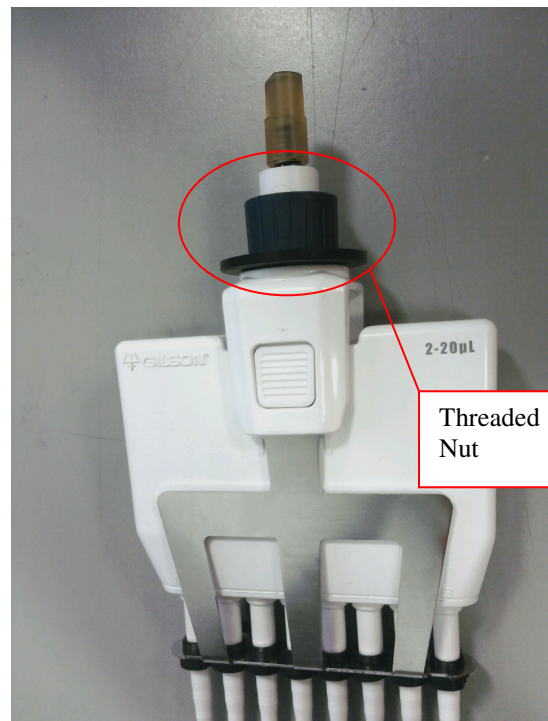
After the Multichannel head is installed onto the SOLO, you must install the Pipettor Latching Bracket onto the assembly. Slide the bracket onto the Multichannel head and line up the mounting holes for the bracket with the mounting holes on the Pipettor assembly. Use the supplied thumbscrews to attach the bracket to the Pipettor assembly. (See Figure 2.5)

Thumbscrews for bracket

Pipettor Latching Bracket
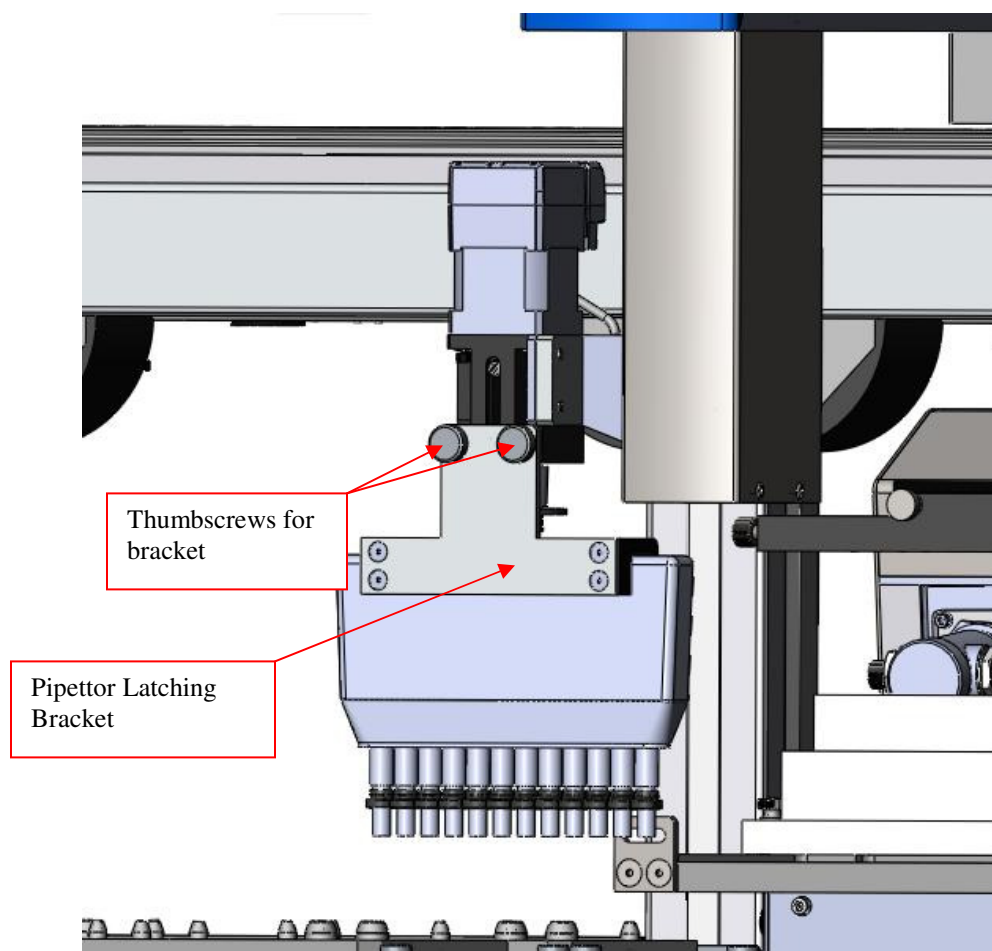
Figure 2.5

3 – Accessories

The SOLO has several options that can be purchased in additional to the SOLO they are the following:

1- Heating/Cooling Nest
2- Shaker next
3- SOLOPlus (SOLO w/attached Micro10x)

Section 3.1 – Heating/Cooling Nest

The Heating/Cooling Nest accessory comes pre-attached onto the SOLO chassis. The power and communication cables are not attached to the unit when it is shipped. Remove them from the shipping crate and install them on the Cooling/Heating Nest. (See Figure 3.1)
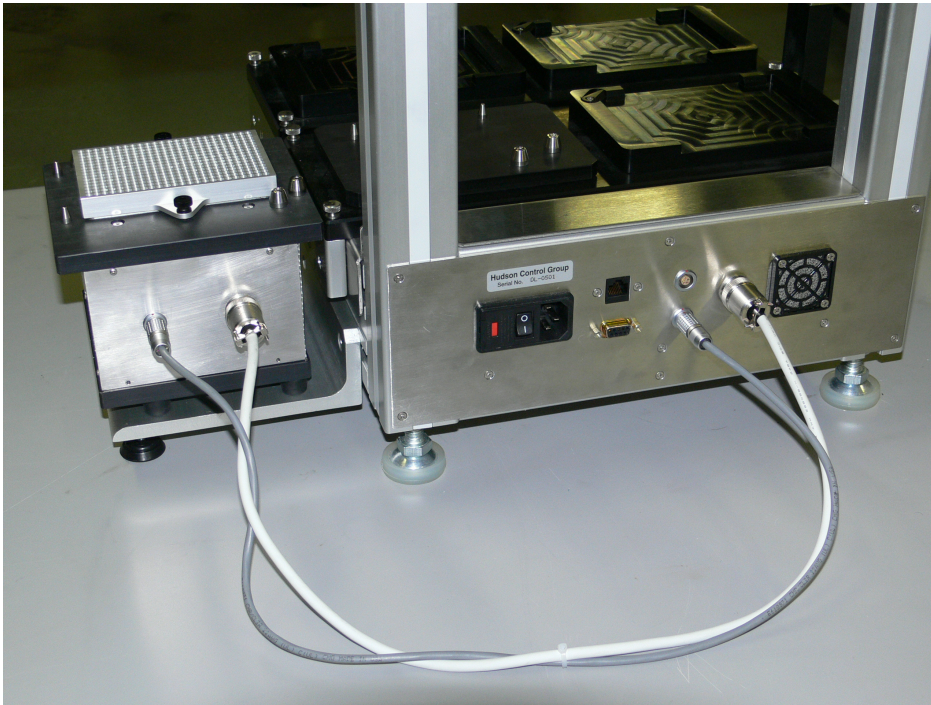
Figure 3.1

Section 3.2 – Shaker Nest

The Shaker Nest comes shipped separately from the SOLO. The Shaker Nest has the same alignment holes that are located in the standard nest plates. To install the Shaker Nest, remove on the nest location and install the Shaker Nest in that location. Plug in the supplied power/communication cable into the Shaker Nest. Plug the communication cable into an available comport on the computer.

Section 3.3 – SOLOPlus

The SOLOPlus option is the addition of a Hudson Robotics, Inc. Micro10x reagent dispenser that is attached to the side of the SOLO (See Figure3.2).   The SOLO is equipped with an alignment bracket that is attaches the Micro10x to the SOLO chassis. This alignment bracket can be mounted in the front position of the SOLO, so that the Micro10x nest is located at the SOLO deck position 6, or in the back position, so that the Micro10x nest is located at the SOLO deck position 5. This bracket contains two

alignment pins which locate the Micro10x into its proper position. During shipping the SOLO and Micro10x are shipped in different boxes. To install the Micro10x onto the SOLO, you will slide the Micro10x next to the SOLO where the alignment bracket is installed. Slowly lift the Micro10x up, so the bottom of the plastic deck is above the alignment pins. Move the Micro10x into position, so that the alignment holes in the Micro10x plastic deck are aligned with the alignment pins in the SOLO bracket. Slowly move the Micro10x down until the Micro10x deck is located on the pins, and that the bottom the Micro10x deck is sitting flush on the alignment bracket. You may have to adjust the feet on Micro10x to re-level the unit to the SOLO deck. (See Figure 3.3)

MC10X Plastic Deck with Alignment holes

SoloPlus Alignment Bracket
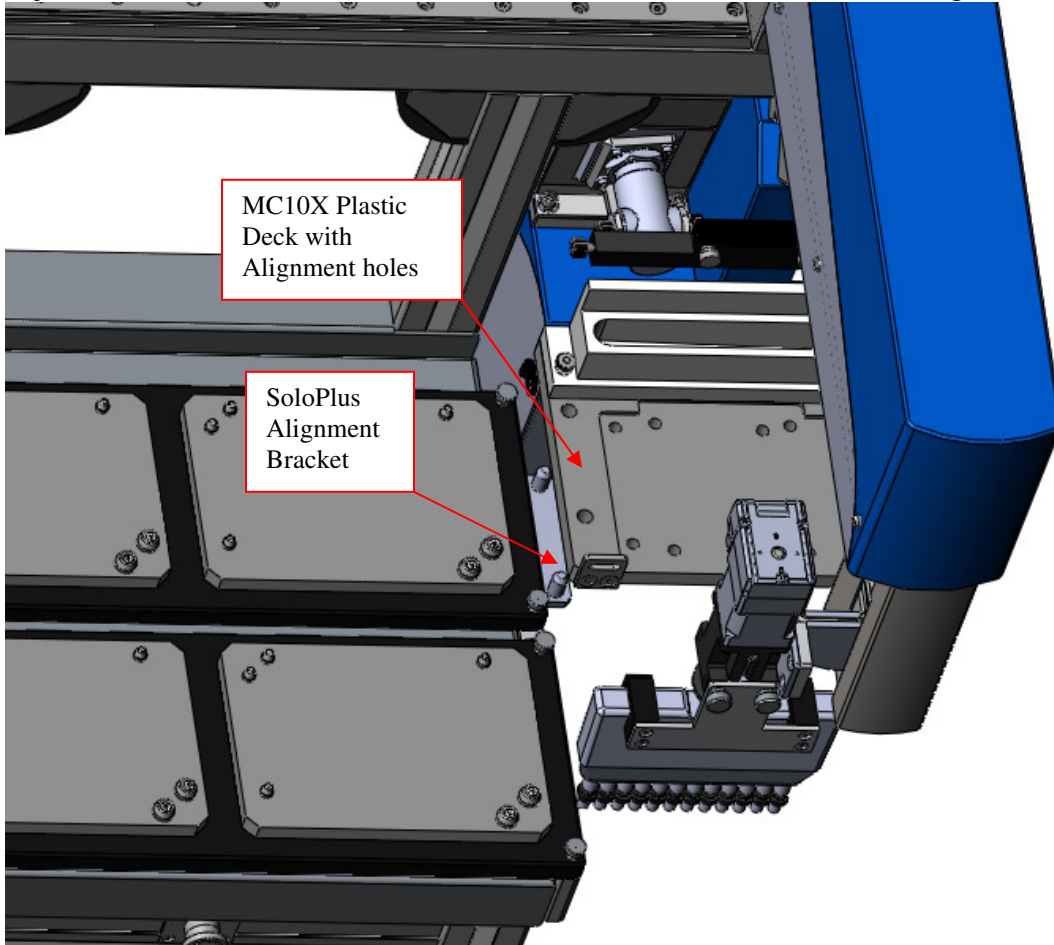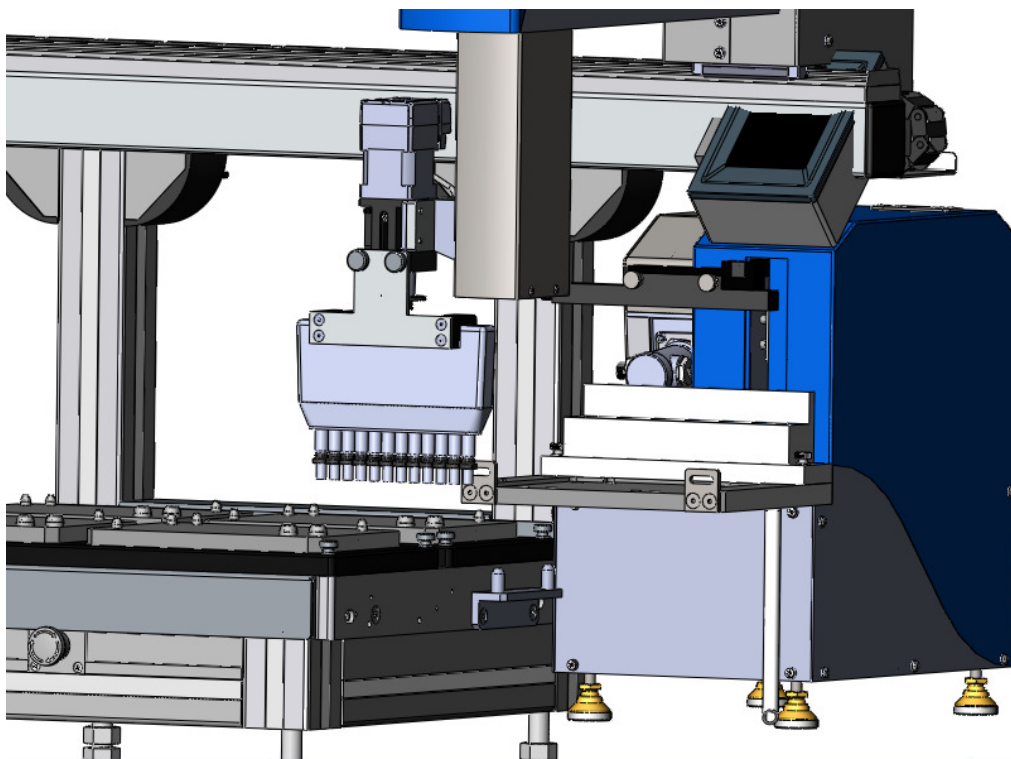
Figure 3.2

Figure 3.3

4 – Hardware Specifications

	SOLO Pipettor	SOLO Pipettor/Dispenser
Hardware features		
Arm configuration	One liquid handling arm	
Tip configuration	1 disposable tip	1disposable tip/Pipetting Needle
Tip variety	Disposable tips with or without filters (10,20,50,100,250 µL)	Disposable tips with or without filters (10,20,50,100,250 µL) or Stainless Steel Pipetting Cannula, various gages and length are available.
Positioning Precision:		
X-axis	± 0.025mm	
Y-axis	± 0.025mm	
Z-axis	± 0.004mm	
Motion Range		
X-axis	594mm (23 3/8")	
Y-axis	244mm (9 5/8")	
Z-axis	101mm (4")	
Liquid handling features		
Pipetting	∨	∨
Bulk Dispensing	N/A	∨
No of fluid sources	N/A	1,3,5,7
Syringe size	125, 250µL	µL

Wash Pump	N/A	Delivery of wash solution by peristaltic pump. Flow: 7,14,21,28 mL Software adjustable.
Safety features		
Password protection		
Emergency Stop	E-stop Button located on the front of the dispenser chassis	
Dimensions	W. 556mm (30") x D. 483mm (19") x H. 610mm(24")	
Weight	27 kg (60 lb)	
Power requirements	Power: 60VA Voltage: 100-240VAC, Frequency: 50/60HZ	
Operating conditions	Temperature 15-32°C/ 59-90°F, Relative humidity 30-80% (non condensing)	
Regulatory compliance		
Computer requirements	PC with Microsoft Windows XP or Microsoft Windows7 Intel Pentium 4 or AMD equivalent. Free disk space 25 MB RAM : 512kB 1 RS232 port or 1 USB port	

	SOLO Multichannel
Hardware features	
Arm configuration	Multiple liquid handling arm
Tip configuration	12 or 8 Channel Disposable tip
Tip variety	Disposable tips with or without filters (20 or 200 µL)
Positioning Precision:	
X-axis	± 0.025mm
Y-axis	± 0.025mm
Z-axis	± 0.004mm
Motion Range	
X-axis	594mm (23 3/8")
Y-axis	244mm (9 5/8")
Z-axis	101mm (4")
Liquid handling features	
Pipetting	ν
Bulk Dispensing	N/A
No of fluid sources	N/A
Syringe size	20 or 200 µL
Wash Pump	N/A
Safety features	
Password protection	
Emergency Stop	E-stop Button located on the front of the dispenser chassis
Dimensions	W. 556mm (30") x D. 483mm (19") x H. 610mm(24")
Weight	27 kg (60 lb)

Power requirements	Power: 60VA Voltage: 100-240VAC, Frequency: 50/60HZ
Operating conditions	Temperature 15-32°C/ 59-90°F, Relative humidity 30-80% (non condensing)
Regulatory compliance	
Computer requirements	PC with Microsoft Windows 2000 or Microsoft Windows XP Intel Pentium 4 or AMD equivalent. Free disk space 25 MB RAM : 512kB 1 RS232 port or 1 USB port

Section 2 – Software

1-Installation

1.1 – Installation CD

Place the SOLOSoft Installation CD in your CD drive. It will automatically begin the Installation process. It will create a folder "C:\Program Files\ SOLOSoft" where the SOLOSoft executable files, the SOLOSoft Active X control, plate definition Access database and support files are loaded. This folder is also the default folder for all SOLOSoft methods, which have the file extension ".hso". Several sample methods are loaded from the CD as well.

### 1.2 – RS-232

Most users will choose to use the included RS-232 cable to connect their computer to the SOLO. If you are using RS-232, a 9-pin female RS-232 connector is located on the rear panel of the SOLO. Connect the provided cable here and to the serial port on your computer. Selecting the serial port assignment and communication parameters is covered in another section of this manual.

2 – SOLOSoft: Main Screen

2.1 - Overview

Upon Startup, SOLOSoft presents the 'Log In' display, which shows the
current Version and a "Log In" button. Click on the button, then enter
your name and password. On initial usage, the default User Name is "Me"
with a NULL password. Under the "Tools Menu" discussion below are
instructions about setting up actual user names and their passwords.

After entering a valid user name and password, the 'Main Screen' display
is shown, as below:
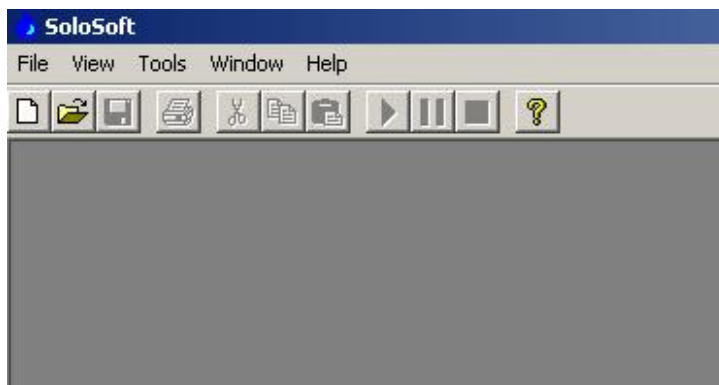
Clicking on any of the five options on the Menu Bar provides the menu
features described in the following subsections.

2.2 – File Menu

New –
   This option creates a blank method whose default name is "Document1",
   and the user can now start developing a new method as described in the
   'Method Development' section below. For SOLOPlus units equipped with a
   multi-channel pipetter, a message box with the question "Do you want to use
   'Single Tip Mode?" will appear on the screen. Selecting 'Yes' as an answer,
   will instruct all steps in the new method to use only one channel of the multi-
   channel pipetter head.   The new method can then be saved under the "Save
   As…" option described.
Open –
   This option allows the user to open an existing method, either to run it or to
   edit it. The default storage folder for existing methods is "C:\Program
   Files\SOLOSoft", however a browse window allows the user to for a method
   file that may be located elsewhere. Multiple methods may be open at the
   same time, with the currently active method being the one whose display is
   out front.

Close –
  This will close the currently active method (the one in front) only.
Close All –
  This will close ALL open methods.

Save –
  This will save the currently active method only, using the path and name
  shown along the title bar of that method.
Save As… -
  This allows the user to select a different path and/or name for the currently
  active method. This new path.name will then appear in its title bar.
Print –
  This will send the currently active method to the user's printer in a text
  format.
Exit –
  This selection will close SOLOSoft.

2.3 – View Menu

Toolbar –
  Checking this option displays the Toolbar buttons along the upper left area of
  the Main Screen, immediately below the Menu Bar. Unchecking this hides
  these.
Status Bar –
  Checking this option displays the status bar across the bottom of the Main
  Screen. Unchecking it hides this bar.
Enable Logging –
  Checking this option will establish a Method Log File for each method that is
  run. Every step executed by the method will have its date and time of
  completion logged, along with process data applicable to that step (if any).
  The log file is saved in the same folder as the SOLOSoft application, and has
  the file name *"MethodName YYYY-MM-DD HH-mm-SS.log"*, where
  MethodName is without the ".hso" extension, and the date/time in the name
  refers to the moment that method is started.
Refresh –
  This refreshes the display of currently opened methods.

2.4 – Tools Menu

Simulated Configuration –
   This option is only active when the communications port (see
   Communications…, below) is set to <none>, forcing SOLOSoft into Simulate
   Mode. This allows the user to try out different SOLO configurations, such as
   switching between 'P', 'D', 'P8' and 'P12' syringe configurations, changing
   syringe volume, and switching from Landscape to Portrait layout:
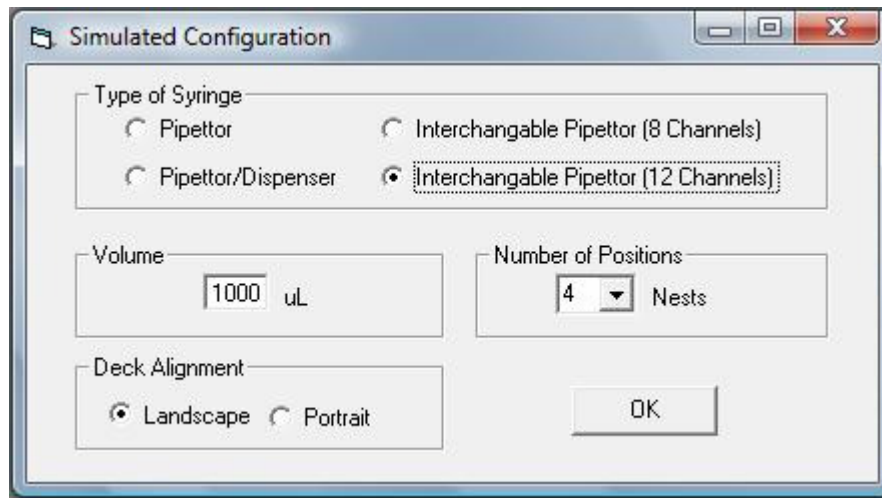
System Liquid (not applicable to simulation mode)
   a. 'P' Syringe Type (Z-axis mounted syringe) –
      This option allow the user to move the syringe piston Up (Aspirate) or
      Down (Dispense) where only the syringe piston moves, not the robot axes:
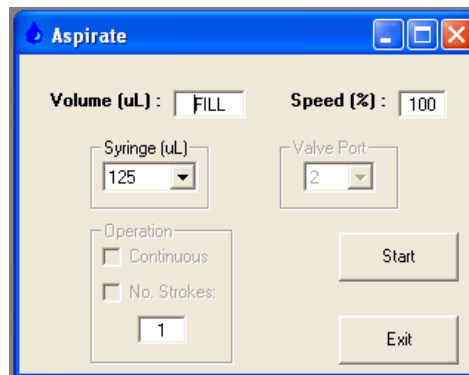
      Aspirate – the user can enter a volume (uL) , or by leaving the volume at
         "FILL", run the syringe piston all the way to the top of its stroke.
      Dispense - the user can enter a volume (uL) , or by leaving the
         volume at "EMPTY", completely empty the syringe by running the
         syringe piston all the way to the bottom of its stroke.

b. 'D' Syringe Type (Side-mounted valved syringes) –
    This option allow the user to move liquid from any of the systems fluid
    reservoir vessels to or from the tip. For both Aspirate and Dispense, the
    reservoir is selected by selecting the appropriate Valve Port in the
    displayed input box:

Aspirate – the user can enter a volume (uL) to move from the tip to the
    reservoir (even volumes greater than the syringe's volume), or by
    checking the 'Continuous' operation box, run the syringe piston
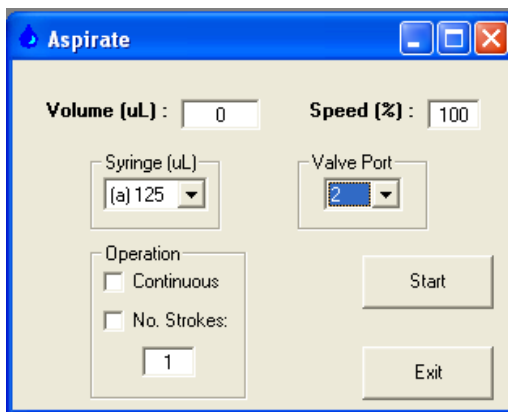   continuously until the user clicks on the "Halt" button. The 'No.
   Strokes' box can be checked and the desired number of aspiration strokes
    entered as another operation option. If there are multiple syringe pumps
    on the SOLO, the Syringe box will drop down to allow the user to select
    any individual syringe or, at the bottom of the list, "ALL" syringes
    operating together.
Dispense – the user can enter a volume (uL) to move from a reservoir to the
    tip (even volumes greater than the syringe's volume), or by
    checking the 'Continuous' operation box, run the syringe piston
    continuously until the user clicks on the "Halt" button. The 'No.
    Strokes' box can be checked and the desired number of dispensing
    strokes entered as another operation option.

Calibrate Deck… –

    This option allows the user to create, teach, save or delete robot positions within the working area of the SOLO's 3-axis robot arm, as well as to jog the arm within that work area. Clicking this option will produce the following screen display:
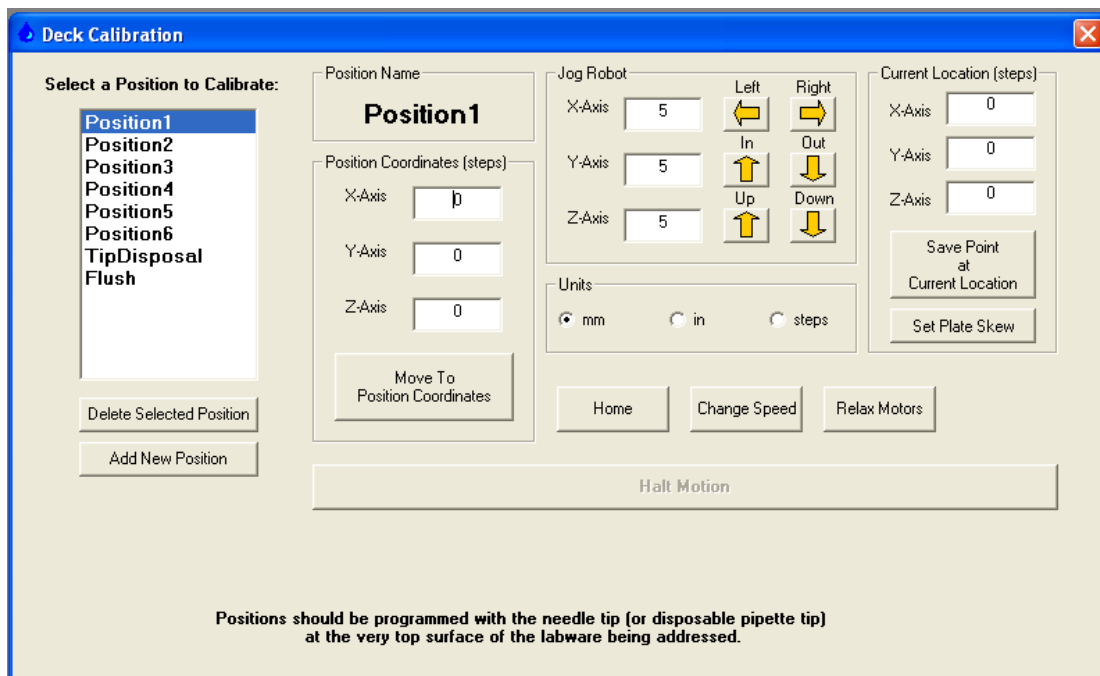
    The first 8 position names in the list are PERMANENT and cannot be deleted, however, the user can re-locate them anywhere within the work area of the robot, however they are intended to be located properly for use in the SOLO's plate nests and tip shucking/flushing stations as follows:

Position1 – the lefthand rear plate-nest location. It should be programmed with a disposable tip pressed onto the syringe tip mandrel (in the case of a SOLO with this option), or using the fixed tip. It is intended to be programmed in the exact center of well 'A1' of a 96-well plate located in that nest position ('A1' being located in the rear left corner of the plate-nest for Landscape layouts, in the right rear corner of this nest for Portrait layouts). Upon clicking the "Save Point…" screen button, SOLOSoft will save this point name with the current X- and Y-axis coordinates, and set the Z coordinate equal to the Z-axis' current 'travel height' setting. This Z-axis setting applies to all 4 (or 6, for Portrait layout) of the plate-nest positions listed here.

Position2 – the lefthand front plate-nest position.

Position3 – the middle rear plate-nest position.

Position4 – the middle front plate-nest position.

Position5 – the righthand rear plate-nest position.

Position6 – the righthand front plate-nest position.

Flush – located with the tip in or above the waste drain fixture.

TipDisposal – located where the syringe tip is within the tip-stripping fixture, with the forks of the fixture surrounding the syringe tip mandrel, and just above the top of a disposable tip so that an upward movement of the robot will strip off the disposable tip.

The coordinates of any position selected from the list along the left will be shown in the box entitled "Position Coordinates(steps)". The user can directly modify these coordinates, then move to the modified coordinates. However, the actual saved coordinates of that position will NOT be overwritten unless the user clicks on the "Save Point at Current Location" button on the right.

The screen button "Set Skew" allows the user to adjust the calculated locations of plate wells in case an individual nest is not in perfect alignment with the X- or Y-axes. Pressing this button when teaching a plate nest position will provide the user with instructions on how to make this adjustment. This is important particularly when dealing with 1536-well plates.

The screen button "Relax Motors" can be used to remove power from all 3 robot axes, allowing the user to manually maneuver the tip to the desired location. Clicking on that button again will restore motor power.

Change Password…-
This allows the *current user* to change his/her password, which will then apply to any subsequent log-ins.

Users… –
This allows a user of Level 3 to add or delete users from the system's database.

Login… -
This allows the user to login using his/her User Name and Password. The User Level will become that of the newly logged-in user.

Notes on User Level Restrictions:

User Level 1: Intended for users who can operate the SOLO but are not allowed to open, change, save or close methods, or use the Communication utility. Level 1 users can run already loaded methods, teach/modify deck positions and change their own passwords.

User Level 2: Level 2 users cannot create new methods, add or delete users, or use the Communications utility. All other SOLOSoft functions are available to Level 2 users.

User Level 3: All SOLOSoft functions are available to Level 3 users.

Define Plate Types… -
This enables the user to define the properties of the various microplates that will be used in the SOLO. The following screen is displayed:

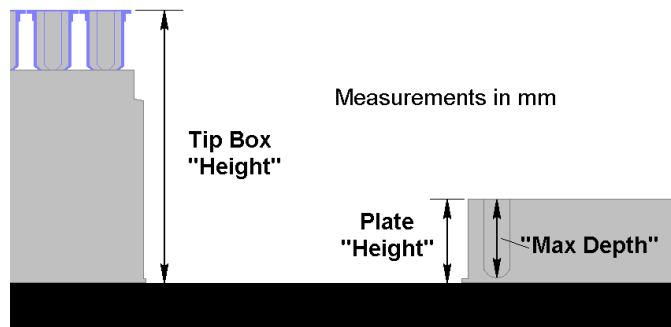| Name	Wells	Height	MaxDepth
▶ 24 Deep Well	24	44	40
96 Deep Protein	96	42	38
Costar 96	96	14.2	3
Costar 96 Polystyren:	96	13	13
Empty	0	0	0
Falcon 384	384	3	5.5
Greiner 1536	1536	12.5	2.1
MJ 96 PCR	96	13	10
My384	384	13.5	6
MyOnlyTips	96	46	42
New Plate	96	0	0
Old Plate1	0	0	0
OmniTray	96	15	15
TipBox	96	46	40
Tips P30_384	384	40	6

Note: 1. All measurements are millimeters
2. For Tip Boxes, enter Tip Length in the "MaxDepth" column.

Save and Exit

The user creates a new plate by placing the mouse cursor in the last row of the "Name" column, then typing in the name of the new plate. The user must also enter the number of "Wells" (the SOLO will calculate the center of each well based upon this), the "Height" of the top of the plate from the nest surface, then the depth of the bottom of the plate's wells, measured from its top surface. This "Max Depth" depth will be limit below which the SOLO needle or disposable tip will not travel when aspirating or dispensing within a SOLOSoft method.

Defining Disposable Tip Boxes and Tips:

When defining disposable **tip box** parameters, the "Height" value should be the height of the top of the tip, as it disposable rests in the tip box, above the surface of the plate nest. The "MaxDepth" value should be the length of the disposable tip (shown as 'Tip Length' in the sketch below), measured from the shoulder of the tip mandrel to the end of the tip, when it has been picked up using a SOLOSoft method's "GetTip" step:

Measurements in mm

Tip Box "Height"

Plate "Height"

"Max Depth"

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Tip Length (mm)
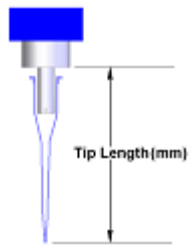
This data is saved in an ACCESS database table "C:\Program Files\SOLOSoft\SOLOSoft.mdb". This must be opened directly if the user wishes to delete a plate type.

Communications… -
This enables the user to select the type of communication to be used by the computer (Serial or TCP/IP), select the RS-232 port (if applicable) or the IP address of the SOLO. The following screen is displayed:
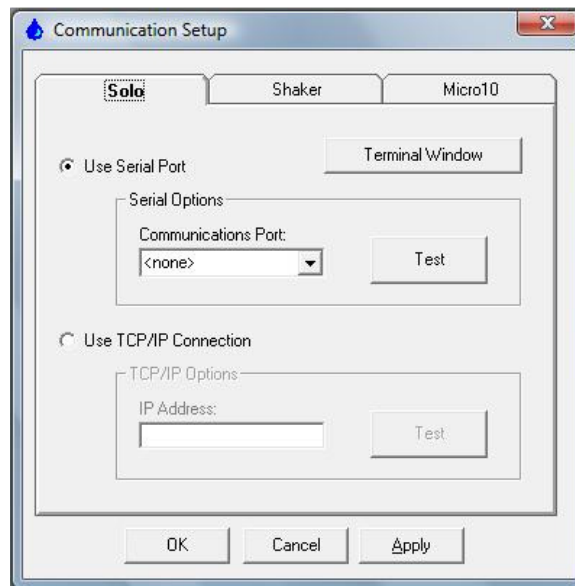
The 'Terminal Window' button provides a HyperTerminal window which will use the Serial port selected in the 'Communications Port' list box to enable the user to use the SOLO's ASCII Command Set (see Appendix A). The user can then issue commands directly to the SOLO from the computer keyboard.

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Shaker Nest Accessory:
   If the SOLO has the Shaker Nest Accessory, the user would setup the serial
   port to control the shaker using the Shaker tab in the Communications display
   form:
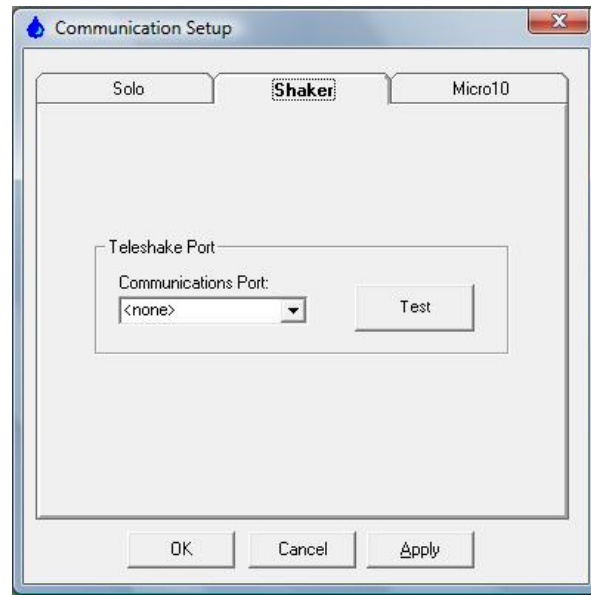
Micro10x Accessory:
   If the SOLO has the Micro10x Accessory, the user would setup the serial
   ports to control the Micro10x and (if equipped) Ten Way Valve using the
   'Micro10' tab in the Communications display form:
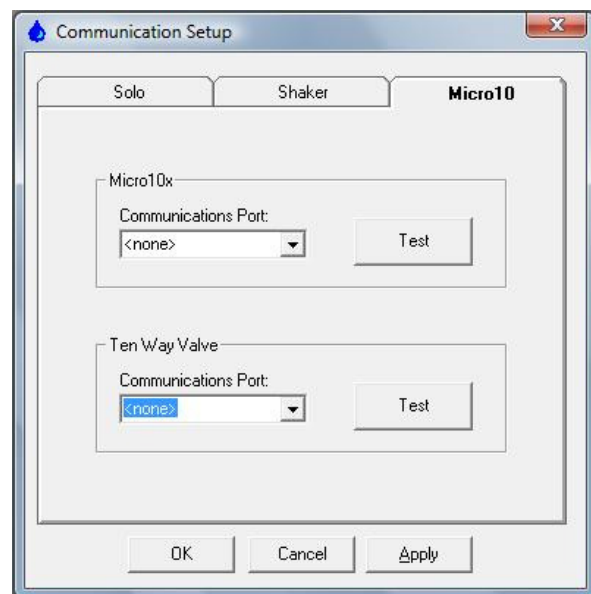
2.5 – Window / Help Menus

The Window menu enables the user to manipulate the window display patterns familiar to users of MicroSoft Windows products. The Help menu's 'About' option will show the current version of SOLOSoft.

3 – Developing SOLOSoft Methods

3.1 – Overview

SOLOSoft enables the user to create, save and run pipettor processes called 'methods'. A method consists of a series of sequential actions, called 'steps', that the SOLO will execute when that method is run. Methods are created and modified using a "drag and drop" editor that is started when the user opens a new method or an existing one, using the File Menu described above. Using the File Menu to select the "New" option will display the following screen:
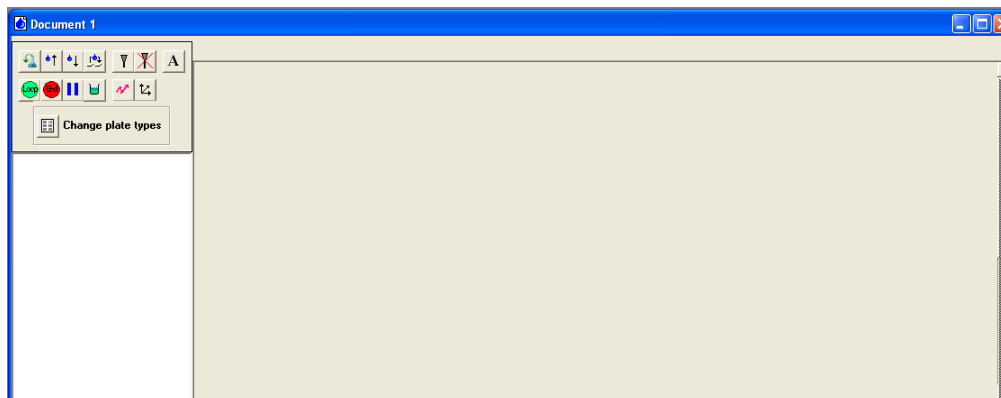
The user adds each desired method step by "dragging" any of the 'Step' buttons, in the toolbar at the upper left, into the white field immediately below, arranging the steps in the order desired by the user. As each step is "dropped" into the white field, the grey area to the right will provide a GUI specific to that type of step that allows the user to define parameters for that step. A completed method will consist of a series of steps arranged in a single vertical column, much like a flow chart. Step types available to the user are described below.

3.2 – Aspirate Step

This step will move the pipettor to a selected aspirate position, then aspirate the indicated volume of fluid. The display shown below depicts an Aspirate step drawing 95 uL from well 'A3' of a 96-well plate located at Position1 on the SOLO's deck on its first execution, then 75 uL from well 'C4' on its second execution (see the LOOP step below):

The user has a number of parameters to select in an Aspirate step:

> Select Type of Source –
>> *Plate Position*: A 'Plate Position' can be selected and identified by clicking on one of the 4 possible deck plate-nest positions (Position1 to Position4) in the deck image above the selection box.
>> *'Named' Point*: if this is selected, the screen will change to that shown at the end of this subsection below, allowing the user to select ANY taught position, whether or not associated with a plate-nest. The available points are selected from a drop-down list shown near the bottom center of the display, and the user would enter the desired volume in the box immediately above this.

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Increment Order – (applies only to aspirating from a plate position for
     SOLO equipped with single tip pipettor head or multi-tip pipettor
     head used in 'Single Tip Mode')
  Row Order (disabled for multi-tip option of 'P8'type syringe) : If a
       multiple number of wells per execution is entered, or
       if this step is within a Loop, each aspiration will increment in the
       order "A1, A2, …. , A12, B1,…, B12, etc.".
  Column Order(disabled for multi-tip option of 'P12'type syringe):
     "A1, B1, … , H1, A2, …, H2, etc.".

     *Note: For multi-tip 'P8' syringe all non-zero volume wells in each
          row will be addressed before moving to the next row.*
     *Note: For multi-tip 'P12' syringe all non-zero volume wells in each
          column will be addressed before moving to the next column.*

     Any wells with a zero volume will be skipped by single-tip units and
     not included in the increment count.

Syringe (uL) –
   This is read from the SOLO's firmware and is selected from a
   dropdown list of the syringes actually on this unit.

Start by Emptying Syringe ('Pn' syringe type only, where n is 0,1,8 or 12)
   Checking this box will cause the needle or tip to move over the
   intended aspirate position, then the syringe piston will move to its
   bottom (empty) position at the start of this step. This is useful to
   ensure that the full capacity of the syringe is available for this
   aspiration. Otherwise the aspiration will start at the last position of the
   syringe piston.

Mixing –
   If the box is checked, immediately after aspiration, the SOLO will
   dispense then aspirate the amount entered the number of times given by
   the 'Mix Cycles' value, ending with a final dispense to leave the
   mixed sample in the well or vessel.

Valve Port ('D' syringe type only, not shown) –
   The user must select the appropriate fluid reservoir by choosing the
   correct valve from a drop down list for the selected syringe pump.

Syringe Speed –
   Scroll up or down to accelerate or slow the syringe piston's movement.

Pre-Aspirate –
   Enter this volume to aspirate air before each aspiration event in this
   step. This allows air pockets to separate each individual aspirated
   sample, and also allows the dispense volume to "blowoff" with
   an air pocket to forcibly expel tip droplets at the end.

Backlash –
  Enter the number (the default is 0) of uL that you wish to have the
  syringe piston move in reverse at the end of its stroke. This is used to
  control droplets or end-of-tip air gaps (also used in a Dispense step) for
  a given commanded volume.

Multiple Wells –
  The number of aspirations done in each execution of this step, in the
  selected row or column order. Any wells with a zero volume will be
  skipped and not counted in the number selected.
  *Note: For multi-tip 'P8' only column order is available and for 'P12'
      syringe only row order is available .*

Switch to File Data –
  If the *'Switch to File Data'* option is selected, the user will be
  shown a browse screen to browse for the file or to just enter its name.
  The selected file and its path will be shown just below the button's
  location. The text on the button will change to "Switch to Entered
  Data" to enable the user to go back to using the plate image table
  across the bottom of the display, and manually enter volume values for
  each well or the named point. The file structure will be determined by
  which type of position is to be aspirated from:

 Aspirate from Plate Position:
  The volume to be aspirated from each well can be imported from a
  comma-separated text file with a row/column format that matches the
  plate type selected for this position (e.g., 8 rows of 12 values each for a
  96-well plate). This file lists each row on a separated line, with each
  column's value separated by a comma, resulting in a file similar to that
  shown below for a 96-well plate:

      50,58,66,74,82,90,98,106,114,122,130,138
      51,59,67,75,83,91,99,107,115,123,131,139
      52,60,68,76,84,92,100,108,116,124,132,140
      53,61,69,77,85,93,101,109,117,125,133,141
      54,62,70,78,86,94,102,110,118,126,134,142
      55,63,71,79,87,95,103,111,119,127,135,143
      56,64,72,80,88,96,104,112,120,128,136,144
      57,65,73,81,89,97,105,113,121,129,137,145

  The file for a 384-well plate would have 16 rows of 24 values each.
  For multi-tip operation only values for wells addressed by first tip of
  multi-tip head are taking in consideration. Tips on the head are
  counted from left to right. See bellow file list for aspirating with 12
  tip head ('P12') from 96-well plate:

      50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50, 50
   42, 42, 42, 42, 42, 42, 42, 42, 42, 42, 42, 42

```
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20, 20
10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10, 10
```

Well positions that have zero (or negative) volume values will simply
be skipped. The SOLO will aspirate from the number of non-zero
wells determined by the "Multiple Wells" setting, then, if inside a
"Loop" , will start at the well following the last one aspirated during
the previous execution of this step.   The volumes to be aspirated will
appear in their respective well locations in the plate image across the
bottom of the display.

Aspirate from 'Named' Point:
The volume to be aspirated from a point, such as a vial location, can
also be imported from a comma-separated text file, but for this type of
position, the values can be in any number of rows/columns, and are
read in left-to-right, top-to-bottom order. As in the case of
aspirating from a plate position above, any zero (or negative) volume
values will simply be skipped. The SOLO will aspirate the next non-
zero volume in the file. If inside a "Loop", it will use the value
following the last one aspirated during the previous execution of this
step. A complete list of the values to be aspirated can be viewed in the
dropdown' list inside the "Aspirate Volume(uL)" box.
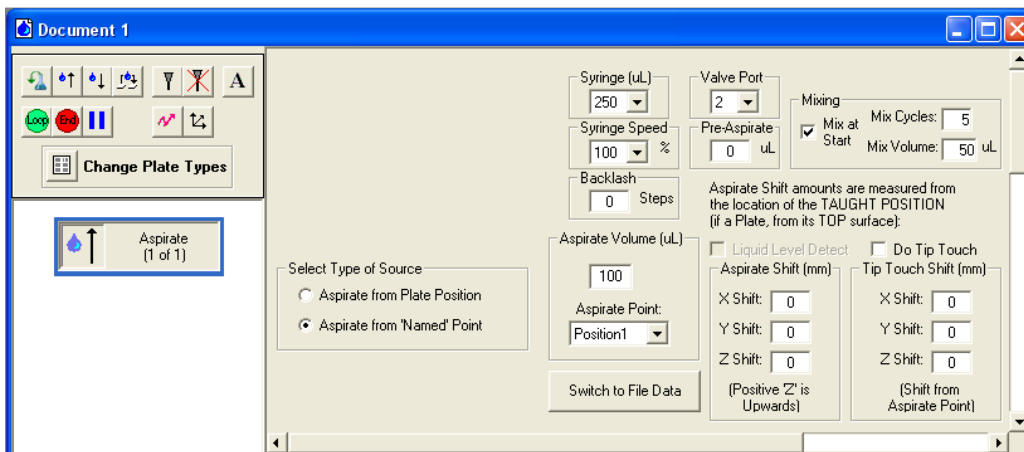
Aspirate Shift –
This enables the user to adjust the actual aspiration location from the
taught position selected for aspiration. This enables the user to go to a
'non-standard' location, or to move in other than well-spacing
increments.

Do Tip Touch / Tip Touch Shift –

This enables the user to do a 'tip touch' to clean a droplet off the tip, and to specify where that tip-touch will be relative to the actual aspiration location. Any shift done in the 'Aspirate Shift' selection above will affect this 'aspirate location'. This will cause the tip to touch twice, on opposite sides of the well or vessel.

Aspirate Volumes (table) –
This graphic shows an image of the plate type selected for this step, and enables the user to enter distinct volumes for each well in the plate. (Important: be sure to pres <ENTER> after entering the last volume into any well location, as it will not be saved if you don't!). As a convenience, you may enter a value in the first element of any row or column, then click on the row/column number to set every well in that line to that value.

Liquid Level Detect –
Units equipped with the Liquid Level Sensing option allow the user to check the box "Liquid Level Detect" box, which will cause the pipette tip to seek the surface of the liquid in the well or vessel being aspirated. If this is checked, a text box labeled "Max. Depth (mm)" is shown. The user should enter the maximum depth of the tip below the upper rim of the well or vessel, below which it will not proceed if no liquid is detected. If aspirating from a defined microplate, and the entered "Max. Depth" value exceeds the Plate Depth value, that plate's Plate Depth value will be used, so as not to drive the tip beyond the bottom of the well. A typical display showing the Liquid Level Detect feature is shown below:
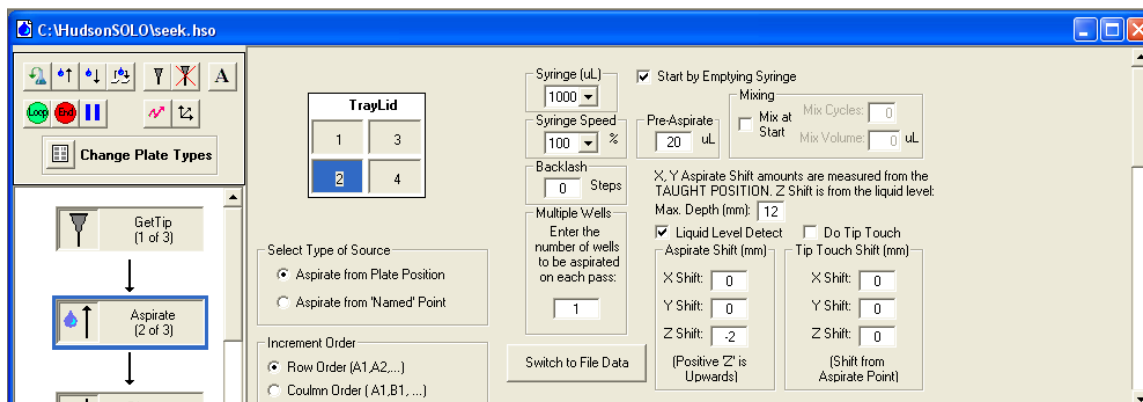
When using liquid level detection, the "Z-shift" value in the "Aspirate Shift" box indicates the distance to move the tip below the detected liquid level prior to aspirating.

If the tip reaches the "Max. Depth" position without detecting liquid, the Aspirate step will end and SOLOSoft will perform its next action.

3.3 – Dispense Step

This step will move the pipettor to a selected dispense position, then dispense the indicated volume of fluid. The display shown below depicts an Dispense step expelling 80 uL into well 'A2' of a 384-weel plate located at Position4 on the SOLO's deck on its first execution, then 75 uL into well 'C4' on its second execution (see the LOOP step below):

The parameter selections are identical to those of the Aspirate step, except for the following:

> Do High-Speed Dispense – If this box is checked, this step will advance between each of multiple dispenses in the step without descending into the well, saving time by avoiding that motion. 'Tip-Touch' is not available if this option is selected.

> Mixing – Same as Aspirate step, except in opposite order, but ends with a dispense as well.

> Blow-off – This amount will be expelled from the syringe after the last 'dispense' amount in this step is released. It is used to blow off a droplets that may be on the tip at the end of dispensing.

3.4 – Get Tip Step

This step, whose GUI is shown in the next figure, will start by shucking any tip that may have been left on the mandrel from a prior activity, then move to the next tip position in a tip box located at, in this example, Position1:
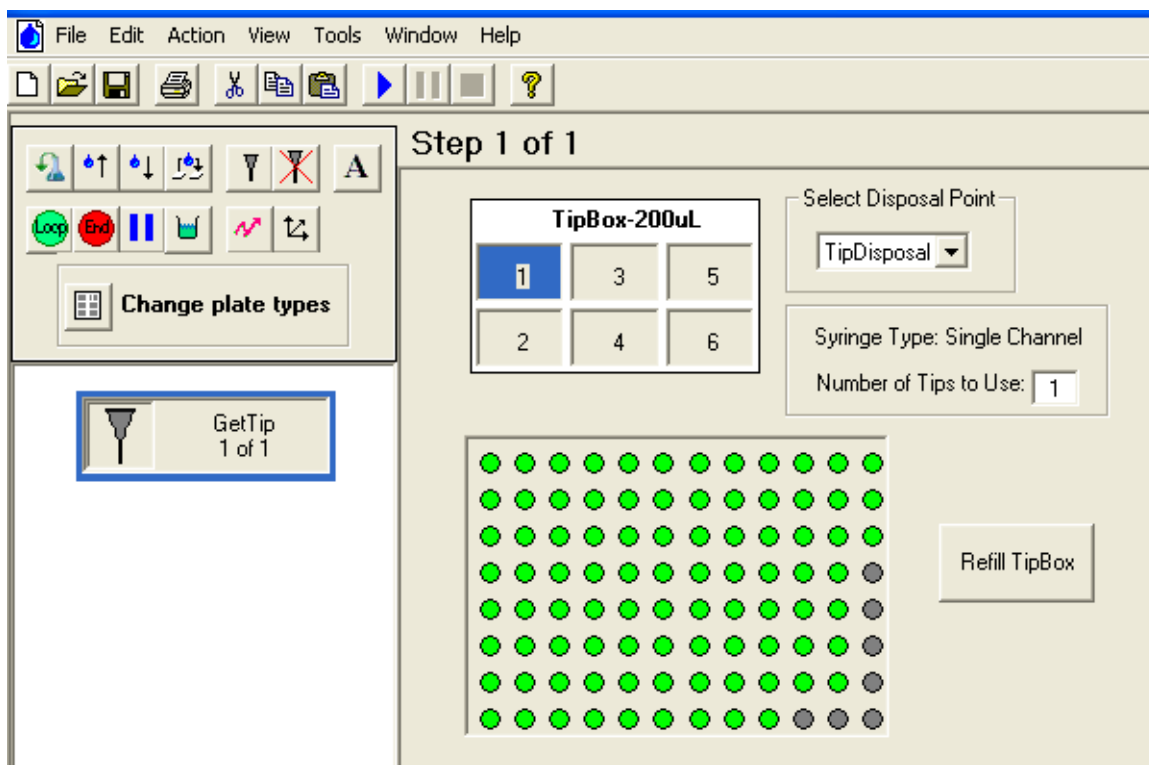
As in the Aspirate step, the location of the tip box is selected by clicking on the appropriate nest position in the displayed deck image. For syringe types 'D' and 'P0' the tip shucking executed at the beginning of this step will occur at the position selected in the "Select Disposal Point" box. For syringe types 'D' and 'P0' below the deck image is a note showing the tip location inside the tip box where the last tip was used. For all syringe types SOLOSoft keeps track of tip count in tip boxes between methods and even if closed and powered-down. For syringe types 'D' and 'P0' the tip retrieved in this step will be the next tip in the box, counted across the box in 'row order'. For multi-tip syringe types 'P8' and 'P12' SOLOSoft keeps track of tips available in tip box for box single-tip and multi-tip operations.

The "last tip" count will be reset to zero if the type of plate at that location is changed, if the identity of that tip box is changed (e.g., if operated using Hudson's SoftLinx scheduling software and a new tip box is moved into that position), or if the tip box is reset in the "Change Plate Types" utility (see that subsection below). In the step's graphic plate image, available tips are shown in GREEN.

For multi-tip syringe type 'P8' utilizing 'single-tip' option the single tip will be taken sequentially from the first available position along columns starting with

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column 1 and row H progressing in direction from row H to A and then columns from 1 to 12. In case of using 'multi-tip' option, 8 tips will be picked up from first available column in the box filled with tips starting with column 1.

For a multi-tip syringe type 'P12' utilizing 'single-tip' option the single tip will be taken sequentially from the first available position along rows starting with row A to row H progressing in direction from column 12 to 1 and then rows A to H. In case of using 'multi-tip' option, 12 tips will be picked up from the first available in the box filled with tips row starting with row A.

For guidance on programming tip pickup positions and using different length disposable tips in different methods, see the subsection below entitled "Programming with Disposable Tips".

3.5 – Shuck Tip Step

This step, whose GUI is shown in the next figure, allows the user to discard a disposable tip at the position indicated in the "Select Disposal Point" box. This is usually used at the very end of a method to strip off a remaining tip. Otherwise, the "Get Tip" step is normally used to shuck a tip prior to getting another.
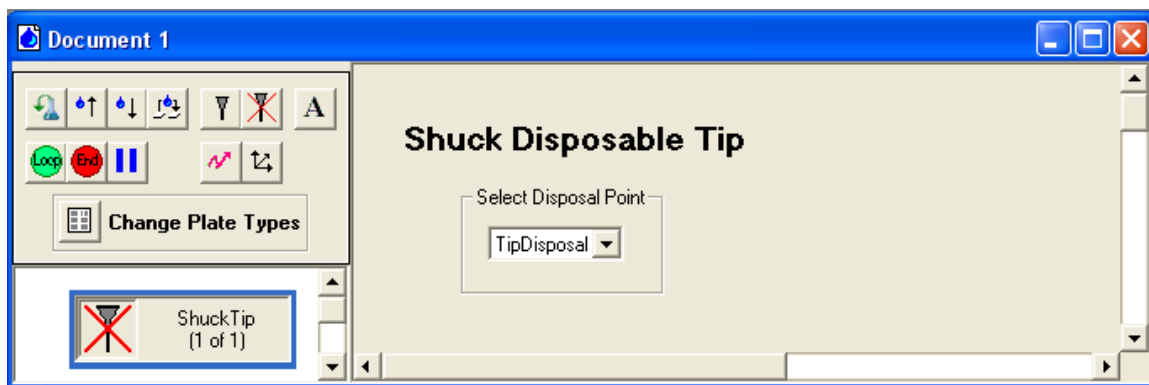
3.6 – Loop / End Loop Steps

These steps, shown in the next figure at the top and bottom of the method flow diagram, allow the user to repeat sequences of steps the number of times indicated in the "Enter NUMBER of Loops to Perform" box. After repeating every step between these two loop steps, the method will continue with the next step after the 'End Loop' step.

Loops can be nested within other loops. If, for instance, a loop with 3 repeats is nested inside a loop with 2 repeats, the steps inside the inner loop will be executed a total of 6 times, while those within only the outer loop will be executed 2 times.

SOLOSoft will pair each 'Loop' step with the very next 'End Loop' that appears in the method. Any 'Loop' without a matching 'End Loop' will be ignored.
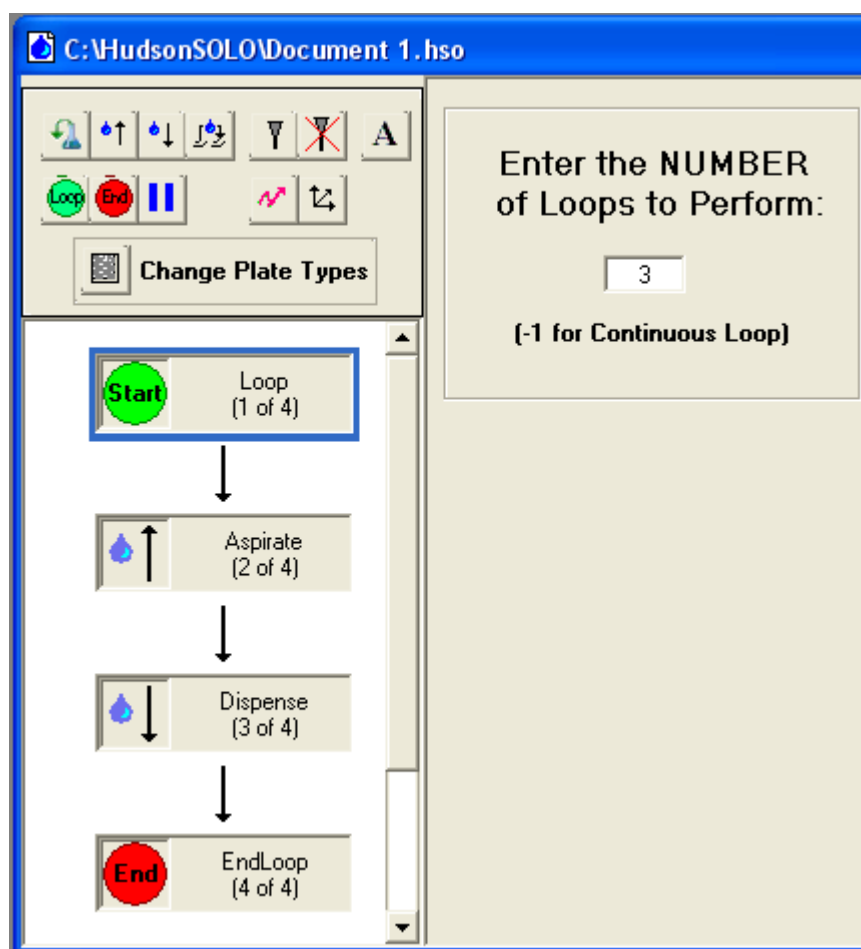
3.7 – Pause Step

This step, shown in the next figure, allows the user to pause the run and present a message to the operator. It also allows the user to permit the operator to end the method at the time of the pause (if, for instance, no liquid was aspirated).

The user types the desired message into the "Enter pause message" box, and allows the operator to end the method by checking the "Allow user to end run at this step?" box.
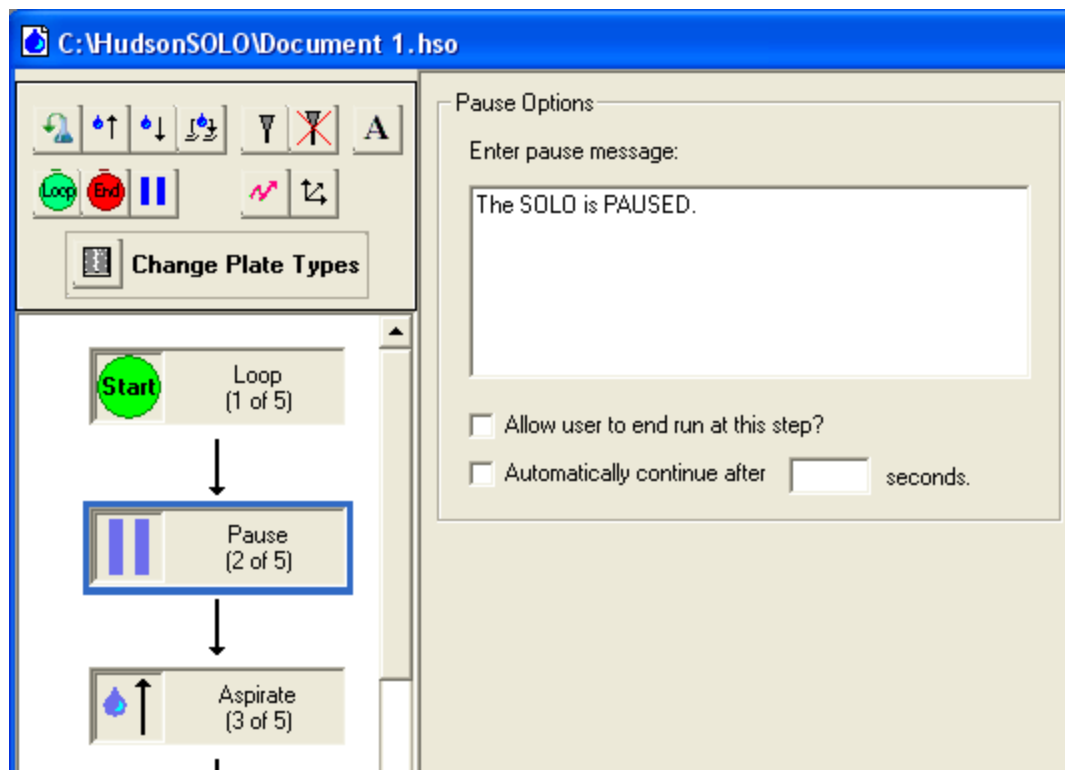
The user may also simply set a timer (in seconds) to pause the method here, then automatically resume after the time has elapsed.

3.8 – Move Arm Step

This step, shown in the next figure, allows the user to simply move the robot arm to any taught position at a speed given as a percentage of the arm's full speed in the "XYZ Speed" box. The 'X' and 'Y' axes move first, followed by the 'Z' axis.
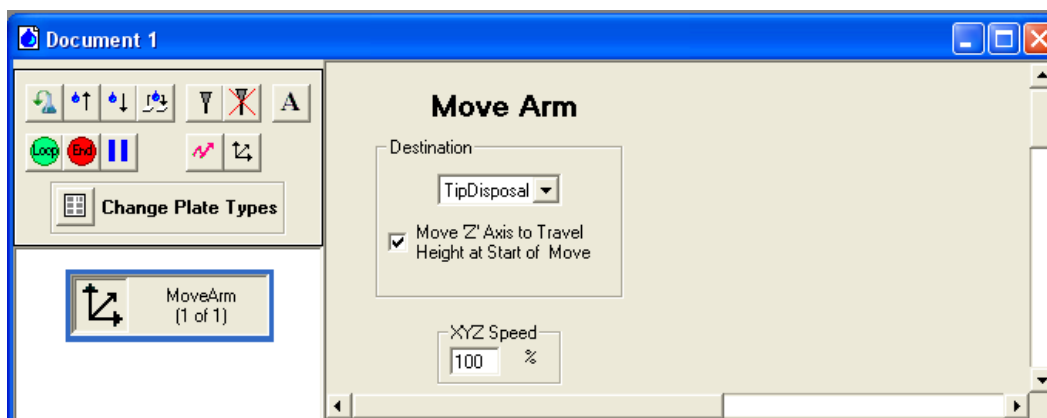
As an option, by checking the "Move 'Z' Axis…" box, the tip will move up to its normal travel height prior to moving laterally to the selected destination position.

3.9 – Set Speed Step

The default robot arm speed is 100% of full speed. This step, shown in the next figure, allows the user to set the movement speed for subsequent steps at the percentage of full speed depicted in the "XYZ Speed" box. This will be overridden by the value set in any "Move Arm" step that may follow.
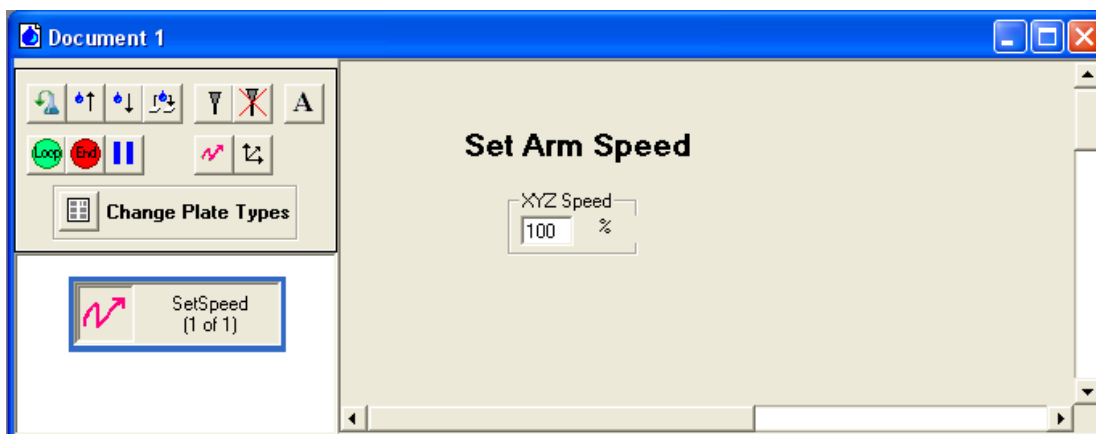
3.10 – Prime Step

The Prime step allows a user to prime or evacuate "D" type syringe liquid lines, or to position a "P" type syringe piston at a desired position, at the start of a method, or even at intermediate places in a method.

The display for a SOLO equipped with a "D" type syringe appears as follows:
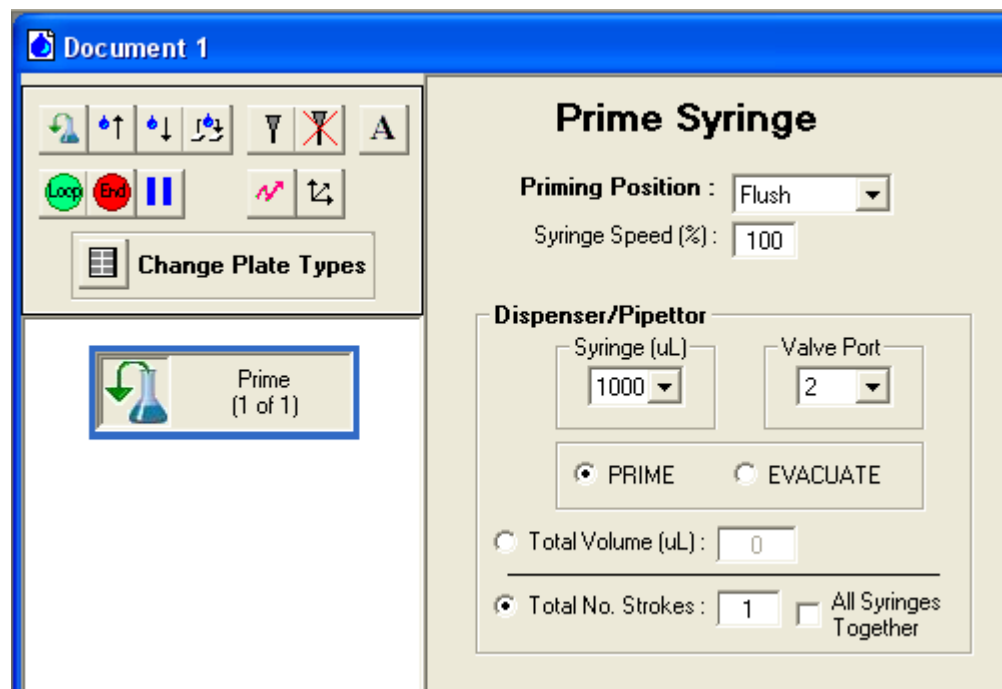
A SOLO can have multiple "D" type syringe pumps (up to 10), and this step allows any individual syringe pump to be exrcised, or all at once. If all are exercised at once, the "Total Volume" selection is greyed-out, and only the "Strokes" selection is allowed. Also, the valve port selection must be the same for all.

The display for a SOLO equipped with s type "P" syringe appears as follows:
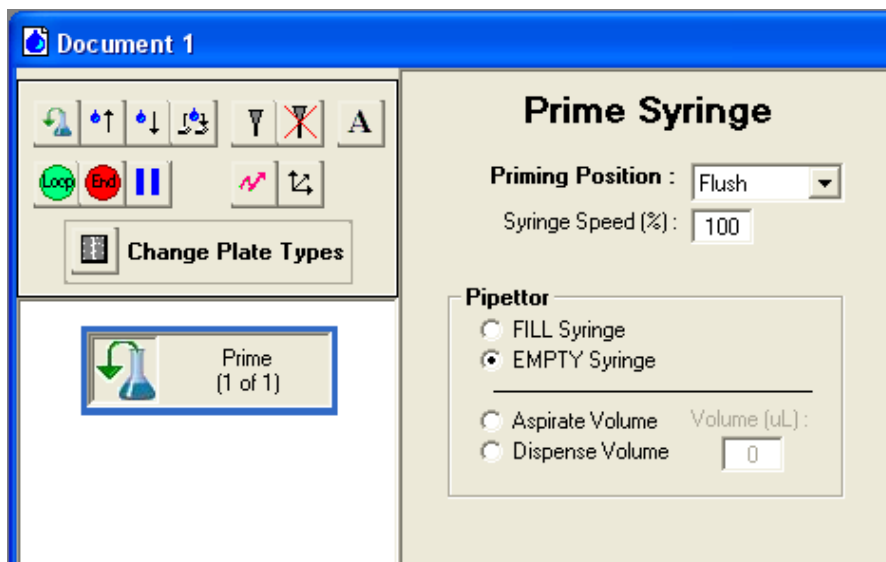
The user make elect to position the syringe piston at the very top of its stroke (FILL) or position it at the bottom of its stroke (EMPTY). Alternatively, the syringe may be moved by a selected amount (in uL), either up (Aspirate) or down (Dispense).

3.11 – HitPick Step (available ONLY for single-tip operation modes)

The HitPick Step provides the user with a convenient way to consolidate the contents of selected wells from one or more source plates into one or more target plates. This step can be used for cherry-picking, rearraying and re-formatting from one size plate to another. The HitPick step is setup much as if it were an Aspirate Step and a Dispense Step combined into one. The user choices as to the syringe selection, syringe speed, X,Y,Z offsets and Tip Touching are similar to those in the Aspirate and Dispense Steps described above, and are not repeated here. The user must select the Source plate's position (out of the available plate nest positions 1 through 4) and the target plate's position. These selections will also define the type of plate that will be present at each of these positions while running, just as in the Aspirate or Dispense Steps above. The major differences between the HitPick Step and the Aspirate or Dispense Steps are:

     a. The Source plate's data ALWAYS comes from a .CSV file, for which the user selects the folder where the source file(s) will be found.

     b. The Target plate's information is derived from a "blocking" pattern that is stored with the method.

     c. The user selects an Output file and file path where the transfer information is to be stored (the same file for all plates in a run).

There must be a separate source file for each Source plate, where that file's name is *SourcePlateBarcode.csv*. For instance, if that Source plate's barcode is

"ABC123", then the file's name would be "ABC123.csv". The file contents are simply the *well name* of each source well, followed by a comma then the *amount* (uL) to be transferred into *each* target well. The format would looks as follows:

> A01,50
> C09,75   (each *well,volume* entry is on a separate line)
> H11,55

The user can use a header line, if desired, of "Source,Well" for clarity. This line is ignored by SOLOSoft if present. The HitPick Step allows the user to fill multiple target wells from each source well, and the amount aspirated from the source well will be that multiple of the amount in the source file. That is, if the user elects to fill 3 target wells from each source well, the amount aspirated from well "A01" above would be 150 uL, with SOLOSoft multiplying the amount in the source file by 3. Each line in the output file has the format "Date,Time,Source Plate Barcode,Source Well,Target Plate Barcode,Target Well,Amount (uL)", with no header line. A typical entry would appear as follows:

> 6/23/2008,2:40:24 PM,ABC123,A03,DEF456,A01,53

The picture below shows the HitPick Step's graphic image:
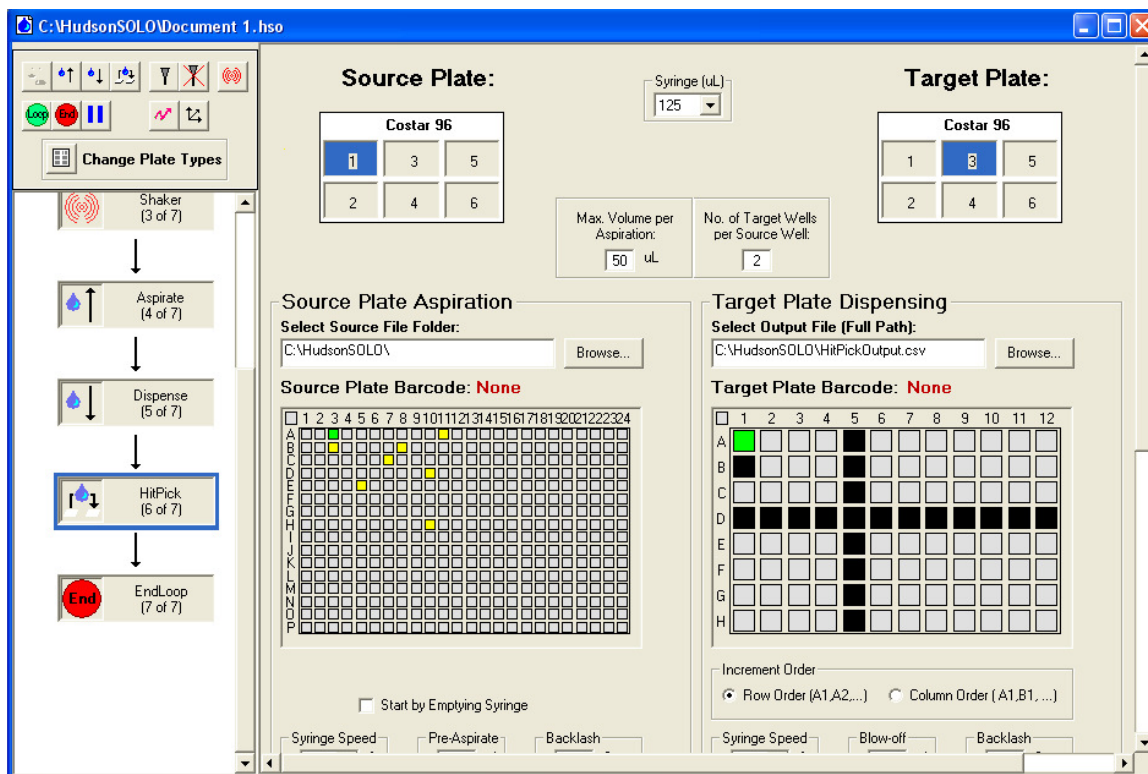
The user can select a Maximum Volume per Aspiration to allow the use of pipette tips that may be smaller than the amount needed to complete the transfer, and may set the number of Target Wells per Source Well. The SOLO will only aspirate up to the Max. Volume each time. If more than one Target Well is to be filled per Source Well, the SOLO will divide that maximum volume by the number of

target wells and dispense equal amounts in each until they receive the full amount required. In order to reduce any effect from pipetting residual volumes at the very lowest end of the pipette tip's range, the next-to-last aspiration step will be limited to 50% of the total remaining aspiration volume so that the last aspiration is also at least 50% of the Max. Volume setting.

The user can browse the computer for the appropriate folder where Source plate files will be found, and can browse or simply enter the full path and name of the output file. Then, before saving the method, can select those Target plate rows, columns or individual wells which will be blocked from receiving transfers from the Source plate. These will be colored *black* as in the above graphic. The user can also select whether to fill the Target plate in "Row" (across the top, then down) or "Column" order. Pending but un-aspirated "hit" wells on the Source plate are displayed in *yellow*, while completed transfers are shown in *green* on both plates.
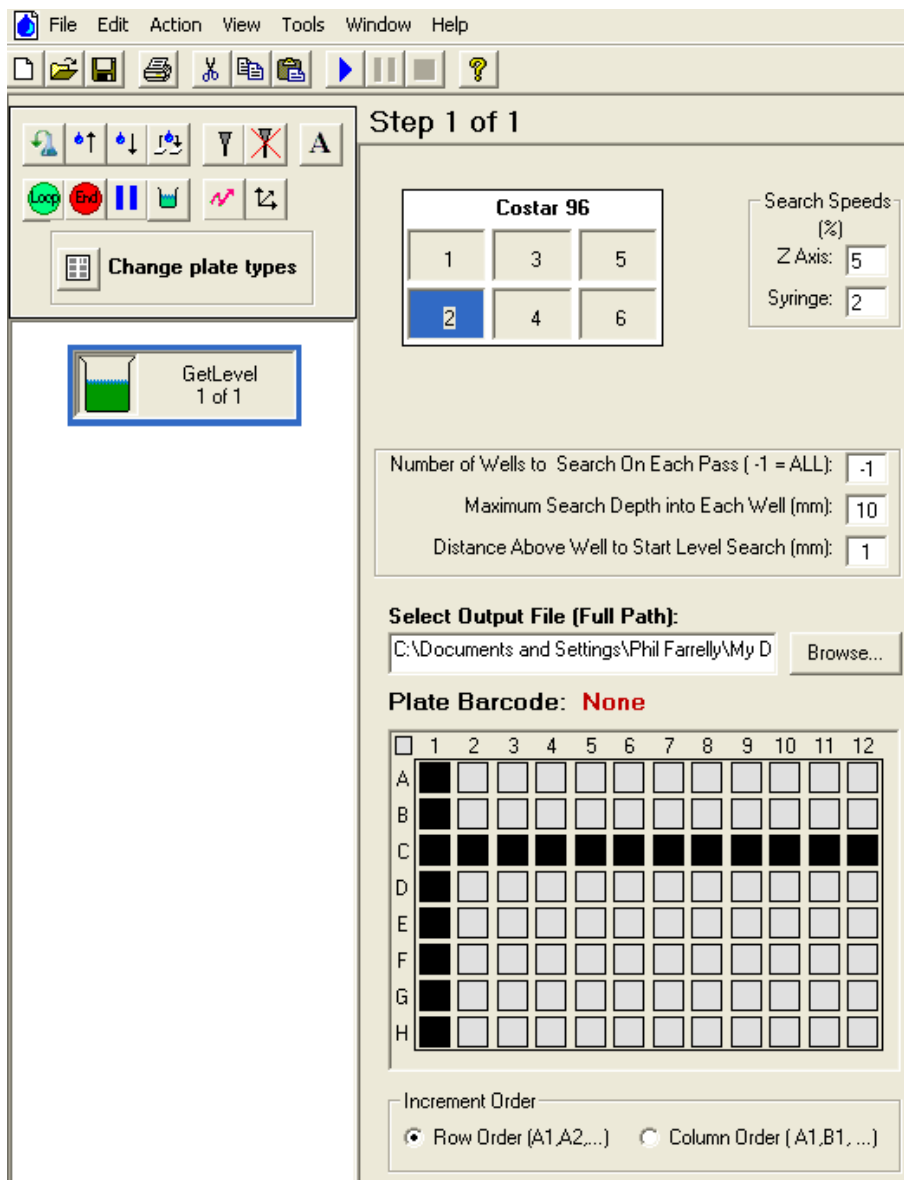
If the Source Plate's "hits" have all been transferred, or if the Target Plate is full, the HitPick Step will end, and, if this step is imbedded inside a Loop, that Loop will end and the Method will proceed with the next step beyond that Loop's End Loop step. Usually, the Method will have been designed to end here to enable replacing either of the finished plates.

Not shown in the graphic above are the aspiration and dispensing settings that the HitPick Step has in common with the Aspirate and Dispense Steps, which are in the lower portion of the HitPick Step's graphic.

3.12 – GetLevel Step

The GetLevel step allows the user to detect and record, in a file, the liquid level inside selected wells in a microplate located at one of the SOLO's six plate nests. The user begins by selecting the plate nest (and its type of plate) where the microplate being measured will be located. Next, using the "Browse…" button depicted in this step's display (below), the user selects the location and name of the file where the liquid level data will be saved.

The user should also select the "Search Speeds" (as percents of full speed) at which the probe tip will descend to the liquid surface, and the speed at which the syringe piston will expel air until the surface is reached. The user must then

select the number of wells to search (entering "-1" to select all unblocked wells), the depth to which the probe should travel before stopping (that plate's well depth, as listed in its definition – see *Define Plate Types…* above - is the limit for this setting), and the distance above the plate to begin the actual search.

The user would then select the order for incrementing the probe from one well to the next ("Row" or "Column" order), and may block out individual wells of entire rows or columns by clicking on the plate graphic at those wells or rows/columns. Those wells thus appearing in BLACK will not be measured.

It is then up to the user to actually use the file data this step produces, such as in a special VB step in SoftLinx or another external software application.

3.13 – Change Plate Types

This utility allows the user to select the type of microplate (or tip box, omni tray, etc.) that is located in any of the 4 plate-nest positions. It also allows the operator to reset any used tip box count to zero, which would have the SOLO start retrieving tips at the 'A1' tip position.
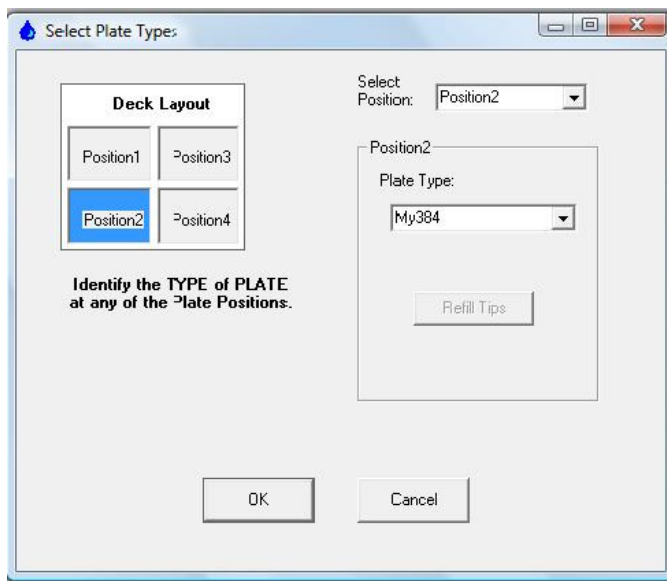
To change a plate type at any of the 4 positions, or to add a plate where the nest was empty, click on the 'down' arrow of the box for that position, and a list of all the defined plate types in the SOLOSoft database will be shown. Clicking on the desired plate will add it to that position. The 'OK' button will save the changes, while the 'Cancel' button will restore the original data. These changes will take effect immediately and remain so while this method is loaded. In order to preserve these changes the next time this method is loaded, the method itself must be saved upon closing it.

3.14 – Operate Accessory

This utility allows the user to operate any of several optional accessories that are available for the SOLO. Drag down the 'Operate Accessory' button to select this type of step. Then select the individual accessory by clicking on its icon button in the display shown below:
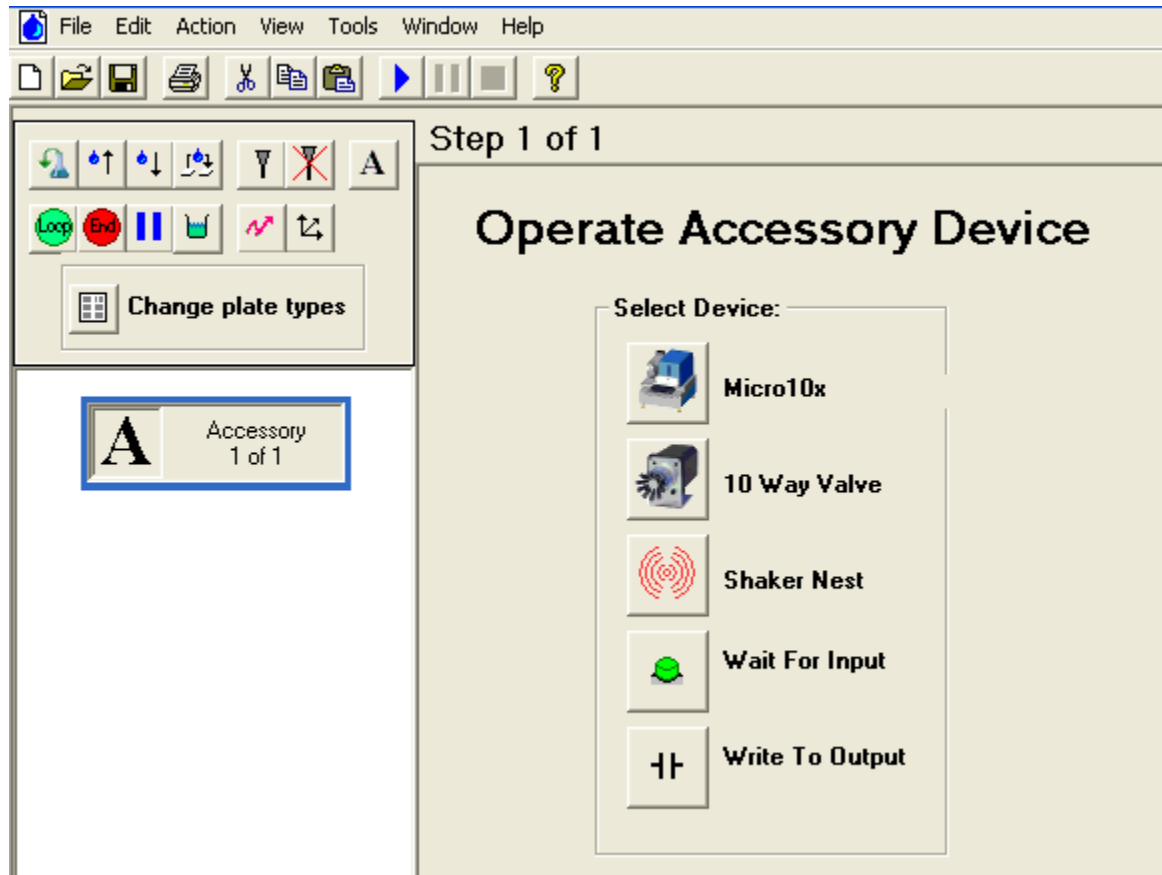
The individual accessory selected will be shown as described below:

3.14.1 – Micro10x

Selecting the Micro10x action for this step will change this step's display to appear as follows:
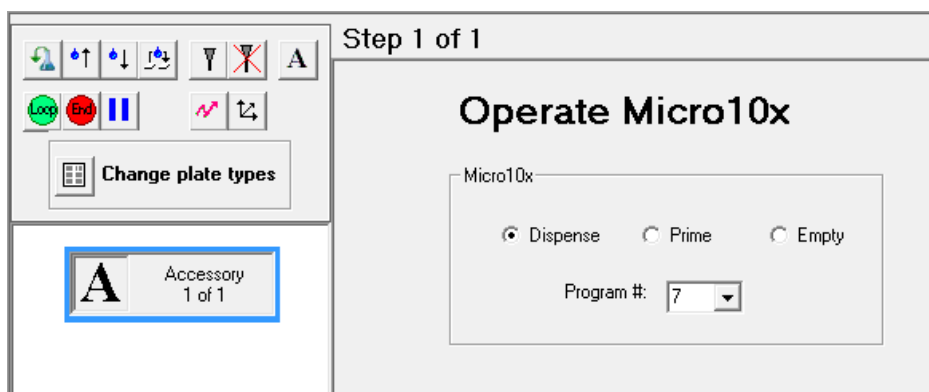
This option allows a SOLOPlus to perform rapid dispensing from an attached Micro10x. The user can select to run a dispense or prime program, or to empty the fluid back into its source. Dispense and prime programs are configured ahead of time in the Micro10x itself. Consult the Micro10x manual for more information on creating and editing dispense and prime programs.

3.14.2 – Ten WayValve

Selecting the Ten Way Valve action for this step will change this step's display to appear as follows:
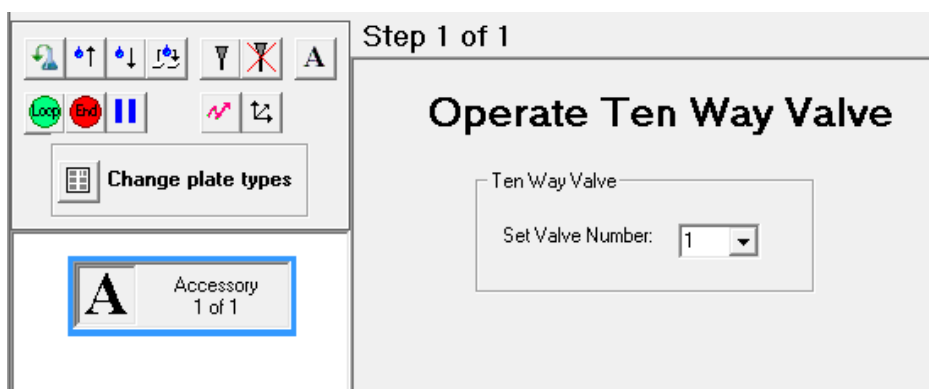
This option allows a SOLOPlus with an attached Ten Way Valve input for the Micro10x to modify the fluid being dispensed by the Micro10x. Execution of the step results in a change in the input valve port on the Ten Way Valve. It is recommended to re-prime the Micro10x after switching fluids. Optionally, the user may want to empty the Micro10x before changing fluid sources to conserve liquids.

3.14.3 – Shaker Nest

Selecting the Shaker Nest for this step will change this step's display to appear as follows:
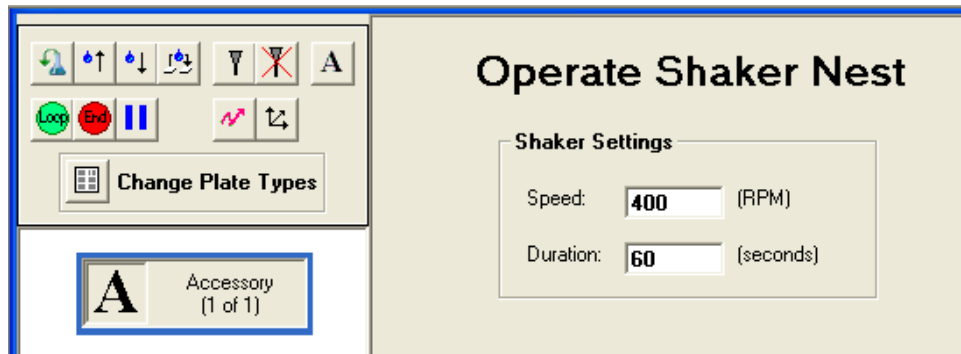
This enables the user to set the speed and duration of a shaking action for the nest, if it is so-equipped.

3.14.4 – Wait For Input

Selecting the Wait For Input action for this step will change this step's display to appear as follows:
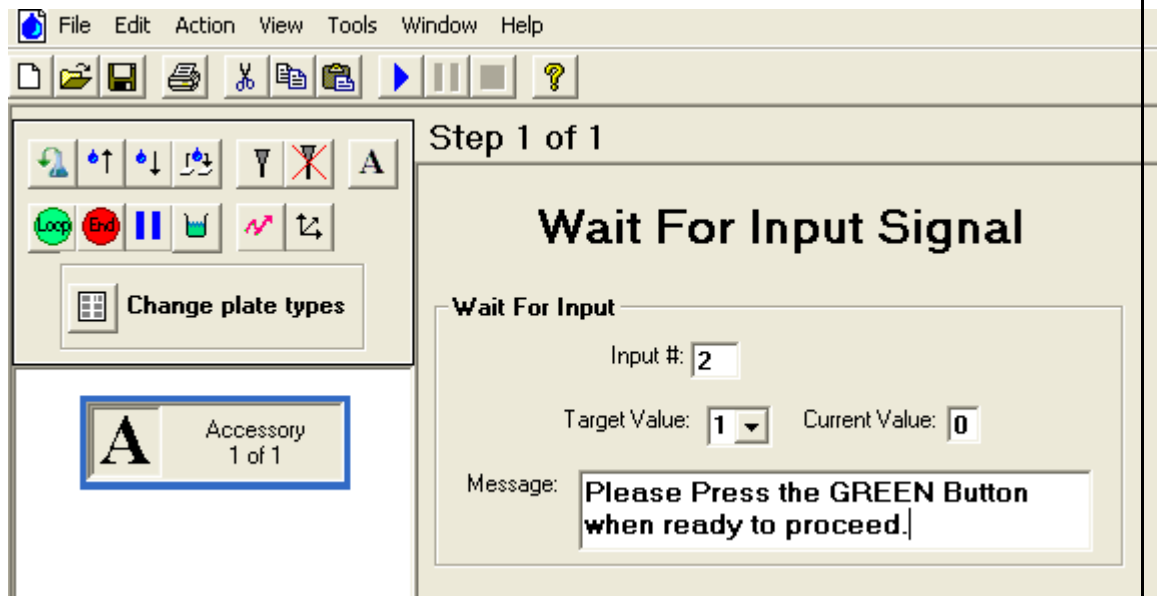
This option allows a suitably configured SOLO to pause here until a digital input signal with the value of "Target Value" (1 or 0) is received from another device, such as a robot or a user-operated pushbutton.

3.14.5 – Write To Output

Selecting the Write To Output action for this step will change this step's display to appear as follows:
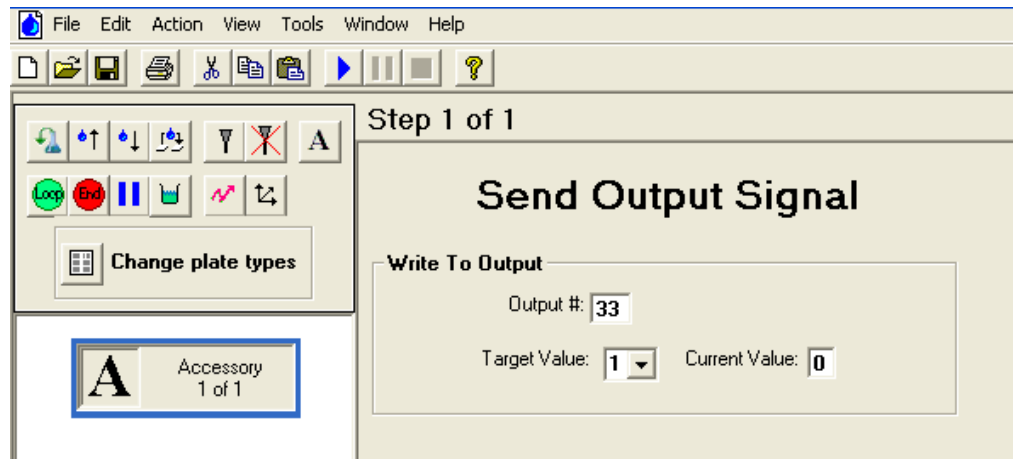
This option allows a suitably configured SOLO to set a digital output signal to the "Target Value" (1 or 0) to provide a signal to device, such as a robot or a mechanical system.

Appendix A – Client/Server Communications

SOLOSoft allows other software applications (such as Hudson's SoftLinx) to start SOLOSoft methods and pass instructions and parameters to SOLOSoft via Windows Sockets in a client/server arrangement.

Upon bootup, SOLOSoft establishes itself as a "server" in the clent/server setup. When started, SOLOSoft attempts to establish a server port at port no. 11139. If successful, it holds that port and can be connected via that port to any client application. If not successful with port no. 11139 (such as when another instance of SOLOSoft is running), this instance of SOLOSoft will advance the port number by 1, and retry. It will retry up to 50 times, advancing the port number by 1 with each failure. If none of these 50 port number succeeds, the error message "Cannot open TCP/IP Socket" will be displayed.

A client application can connect with SOLOSoft by attempting to connect over the same socket port that SOLOSoft has opened, starting with11139, then advancing by 1 if this fails until a connection is established.

Once a connection is established, a client application can send the following messages to control and query SOLOSoft. Each command to SOLOSoft consists of a command string ending in a binary 3 (ETX). SOLOSoft will send a reply containing the data requested or, if no data is requested, SOLOSoft will send the string "0000<ETX>" to confirm a valid command was received. The client application must then send the response string "OK<ETX>", which tells SOLOSoft the client has received SOLOSoft's message. If the client sends an invalid command, SOLOSoft will respond with "0001 Unrecognized Command: *<the commandstring it received>*<ETX>". If a command has arguments, the first argument is separated from the command by a space, while the individual arguments are separated by commas. An illustration of the communication protocol is as follows:

| **Application** | **SOLOSoft** |

ADDPLATE Position1<ETX> →
                              ← 0000<ETX>
                OK<ETX> →

ADPLATE Position2<ETX>   →
                              ← 0001 Unrecognized Command: ADPLATE<ETX>
                OK<ETX> →

The invalid command contains a misspelling of the command itself.

Valid commands are listed below:

ADDPLATE *PositionName[,PlateBarcode]* - Tells the SOLO that a plate with a barcode ID of *PlateBarcode* has been delivered to the SOLO's deck at nest *PositionName*. If *PlateBarcode* is omitted, just use *PositionName* and leave off the extra commas.

CLOSE - Causes SOLOSoft to self-terminate.

GETMESSAGE – Obtains a string that the SOLO method creates at the end of a SOLO method's run. This value is nulled out upon being read via this command, and at the beginning of any method run. It will contain either an error message, if the method ended in an error condition, or will have the value "0000" if the Method ended successfully.

GETMETHOD - Obtains the name of SOLOSoft's currently loaded, active method.

GETPATH - Obtains SOLOSoft's current folder (where SOLOSoft.exe resides)

GETSTATUS - Obtains SOLOSoft's current method's running state: "IDLE", "RUNNING", "PAUSED" or "STOPPING".

GETTIPCOUNT *PositionName* - Gets the number of the last tip to be removed from a tip rack at *PositionName*.

GETUSERPATH - Obtains the default folder where SOLOSoft methods and user data files are stored.

GETVALUE *VariableName, PositionName* - Currently, the only VariableName supported is "NESTSTATUS", which returns the status of the SOLO's *PositionName* nest: "EMPTY" or "FULL".

LOAD *FullMethodPathName* - Causes SOLOSoft to load the pre-saved method. *FullMethodPathName* must contain the full path and file name (with extension) of the method, which now becomes the currently active method.

PAUSE - Causes SOLOSoft to pause execution of the currently active and running method.

RESUME - Causes SOLOSoft to resume execution of the currently paused method.

RUN *FullMethodPathName* - Causes SOLOSoft to load (if not already loaded) and run the method *FullMethodPathName* (see LOAD above).

SETNAME – Allows the client application to give this SOLO unit a "name" that may differentiate it from another SOLO that may be in the system. The default name is "SOLO Pipettor".

SETNESTSTATUS – Sets the status of a SOLO's plate nest position to enable the client application to properly react to that status (such as "REMOVE" or "FULL").

SETUP - Causes SOLOSoft's window to expand to full size and the foreground.

SETVALUE *VariableName, Index, Value* - Enables the client application to set variable values that SOLOSoft's method will use. Four variable names are currently supported:

1. LOOPCOUNT, *Index, Value*: Enables the client to set the number of iterations of LOOP step *Index* to *Value* in the current method. Index starts at 1 for the first LOOP step in the method, and increments for each subsequent LOOP step, if multiple LOOPs are present.
2. NESTSTATUS, *Index, Value*: Allows the client to set the status to *Value* ("FULL" or "EMPTY") of the SOLO nest at Position*Index*, one of the plate nest names on the SOLO (e.g., "Position1").
3. OUTPUTFILE,, *FullPathName*: Allows client to specify the full path and file name (including file extension) of the output file to be used by any HITPICK step in the current. This will override the file path/name that was saved with the method. The second argument may be left blank.
4. SOURCEFOLDER,,*FullPath*: Allows the client to specify the folder where the current method's HITPICK step(s) will look for the input Source file, which is always named *PlateBarcode.csv*, where the source plate's barcode is input from a different place in the application. *FullPath* must end in a backslash ("\").

STOP - Causes SOLOSoft to stop the current running method, but leave it loaded and current.

Appendix B – RS-232 Communications and Command Set

Firmware Version 7.00

Hudson's SOLO Single- or Multi- Channel Pipettor/Dispenser is designed to respond to a simplified set of ASCII commands to allow any user program capable of reading/writing via an RS-232 port or TCP/IP connection to exercise all the features of the SOLO.

Protocol Description

The RS-232 connection for the SOLO operates with the following communication specifications:

Baud Rate:	38400
Data Bits:	8
Stop Bits:	1
Parity:	None
Handshake:	None
Device Type:	DCE
Connector:	9-pin, female

For TCP/IP communication, each unit must have a unique IP address assigned. This can be accomplished with the SETIPADDR command. The computer should then connect to this IP address on TCP port 7.

SOLO commands have the following format:

{command} {parameter1},[{parameter2}],…,[…]<13><10>

The {command} portion is the actual command to be executed by the pipettor. This may be followed by a comma-separated list of parameters as specified in the individual command descriptions. Arguments listed inside square brackets ([…]) are optional.

All SOLO commands are terminated by a carriage return / line feed combination (ASCII characters 13 and 10). The command is then delivered to the pipettor unit, which parses, validates, and executes the requested command before returning a response. Commands may be sent to the SOLO while it is processing other commands. The SOLO can queue up to 10 commands. The behavior when the queue when overloaded is currently unspecified. There is currently no message indicating that the command queue has been overloaded.

The following example would send the DISPENSE command, with an argument indicating to dispense at position "Plate1", a volume of 10 uL, at a syringe speed of 100% of normal stroke speed:

DISPENSE Plate1,10,100<13><10>

A space is required between the command and its argument string. All are ASCII text characters as shown (except the carriage return and line feed, which are binary bytes).

Command Responses

The controller will echo every byte of the command back to the sender as it is received. Upon detecting the two bytes <13><10>, the controller will execute the command. Upon completing execution, the controller will respond in one of two ways:

1. For query commands, where a data response is required, it will return:
{data response}<13><10>
2. For action commands or invalid queries, it will return:
{error code} {error description}<13><10>

If an action is requested, or an error occurs the response will be a 4 digit error code, a space (ASCII character 32), and a short description of the error that occurred. A response of "0000 Success" represents a correctly executed command. Other responses will indicate an error.

As examples:

1. Valid query command:
   Command: GETPOS<13><10>
   Echo: GETPOS<13><10>
   Response: 0,0,0<13><10> (i.e., current x,y,z coordinates)

2. Valid action command:
   Command: MOVE Position1<13><10>
   Echo: MOVE Position1<13><10>
   Response: 0000 Success<13><10> (i.e., action successfully executed)

3. Invalid query command ("Washer" is an unknown position):
   Command: GETPOINT Washer<13><10>
   Echo: GETPOINT Washer<13><10>
   Response: 0002 Invalid Parameter<13><10> (invalid point name)

Note: If any command contains an error, the StackLink sends the response immediately, otherwise the response is sent at the completion of execution.

Hudson SOLO Command Set

The SOLO recognizes the following commands:

1.   ASPIRATE PointName, Volume (uL), [Speed (% of normal stroke speed)], [Backlash (uL)], [Syringe ID letter]. Aspirates the indicated volume at the indicated position. Speed is optional, and defaults to 100. Backlash is optional, and defaults to 0. Syringe letter ("a" or "b", etc.) is required with the 'D' type of syringe if only one syringe is desired to act and if the SOLO is equipped with more than one syringe pump. Eliminating the syringe ID letter (or using a letter above 'j') will cause ALL the syringes to obey the command. Syringe ID is only meaningful with the 'D' configuration.

        Example:

        Command: ASPIRATE Position1,50, 25,6<13><10>
        Response: 0000 Success<13><10>

2.   CLEARPOINTS
        Clears all stored positions

        Example:

        Command: CLEARPOINTS<13><10>
        Response: 0000 Success<13><10>

3.   DELETEPOINT PointName
        Deletes the position PointName

        Example:

        Command: DELETEPOINT Position1<13><10>
        Response: 0000 Success<13><10>

4.   DISPENSE PointName, Volume (uL), [Speed (% of full stroke speed)], [Backlash (uL)] , [Syringe ID letter]. Dispenses indicated volume at the indicated position. Speed is optional, and defaults to 100. Backlash is optional, and defaults to 0. Syringe ID ("a" or "b", etc.) is required with the 'D' type of syringe if only one syringe is desired to act and if the SOLO is equipped with more than one syringe pump. Eliminating the syringe ID letter (or using a letter above 'j') will cause ALL the syringes to obey the command. Syringe ID is only meaningful with the 'D' configuration.

Example:

Command: DISPENSE Position2, 50, 80,4<13><10>
Response: 0000 Success<13><10>

5.   EMPTY [Volume (uL)], [Speed (% of full stroke speed)] ('P' configuration ONLY)
Both arguments are optional. If none are given, the syringe goes to the bottom of the stroke, otherwise it dispenses the given volume at the indicated speed. If speed control is desired, but syringe needs to go to bottom of stroke, use "0" for Volume and the desired setting for Speed. See FILL.

Example:

Command: EMPTY 50,25<13><10>
Response: 0000 Success<13><10>
          Or, to go to bottom:
Command: EMPTY <13><10> or EMPTY 0,25<13><10>
Response: 0000 Success<13><10>

6.   EVACUATE [Volume(uL)], [Speed(%)], [Syringe ID letter] ('D' configuration ONLY)
All arguments are optional. The syringe will operate at the speed given (100 is the default) until the specified volume is moved from the tip into the currently selected reservoir. If no, or 0, Volume is specified, the syringe will continuously move fluid (or air) from the tip into the currently selected reservoir, emptying the line, and requiring a "HALT" command to stop the process. If a negative value is given for Volume, the positive integer of that value will be the number of syringe strokes to be executed, with the first stroke just bringing the syringe to the bottom of its stroke. If Syringe ID is omitted, or if a syringe ID letter above 'j' is used, ALL syringes will be operated together. See PRIME.

Example:

Command: EVACUATE 1000,25,b<13><10>
Response: 0000 Success<13><10>

7.   FILL [Volume (uL)], [Speed (% of full stroke speed)] ('P' configuration ONLY)
Both arguments are optional. If none are given, the syringe to the top of the stroke, Otherwise it aspirates the given volume at the indicated speed. See EMPTY.

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8. GETDECKHEIGHT [Position#]
    Returns the distance (mm) of the deck surface of plate nest "Position*x*" from the
    shoulder of the mandrel at the Z-axis' lower limit, and its calculated coordinate in
    motor steps that would be the Z-position of the tip mandrel if it could reach the deck
    surface of the plate nests. If the position # is omitted, the deck height at Position1 is
    returned.

    Example:

    Command: GETDECKHEIGHT<13><10>
    Response: 25.5 mm, 33250 steps<13><10>

9. GETDISPTIPCURRENT
    Returns the LOW and HIGH Z-Axis running current range to use when performing
    the GETTIP command. The current is adjusted linearly between the LOW and HIGH
    values in proportion to how many tips are to be retrieved (1 to 12).

10. GETDISPTIPSPEED
    Returns the LOW and HIGH Z-Axis velocity range to use when performing the
    GETTIP command. The speed is adjusted linearly in inverse proportion between the
    LOW and HIGH values in proportion to how many tips are to be retrieved (12 to 1).

11. GETFULLSTROKE
    Returns the current number of stepper motor steps per full stroke of the syringe.

    Example:

    Command: GETFULLSTROKE<13><10>
    Response: 3750<13><10>

12. GETIPADDR
    Returns the current IP address of the unit.

    Example:

    Command: GETIPADDR<13><10>
    Response: 192.168.1.2<13><10>

13. GETLAYOUT

Returns an 'L', for landscape (default), or a 'P', for portrait. 'Landscape' layout has the plate positions arranged so that 'A1' is at the left rear corner of each plate, with row 'A' running along the rear edge of the plate, from the user's perspective facing the SOLO. 'Portrait' has 'A1' at the right rear corner of the plate, with row 'A' running along the right edge of the plate. Immediately following the "L" or "P" is a number indicating the number of nest positions this unit has on its deck.

Example:

Command: GETLAYOUT<13><10>
Response: P5<13><10>

14. GETLEVELSENSING

Returns a '1' if the level sensing option is installed and activated, a '0' otherwise.

Example:

Command: GETLEVELSENSING<13><10>
Response: 1<13><10>

15. GETLIMITS

Returns the limits of each axis of motion. The limits are returned in the following order: Xmin, Xmax, Ymin, Ymax, Zmin, Zmax

Example:

Command: GETLIMITS<13><10>
Response: -500, 1250, -415, 4250, -4575, 20525<13><10>

16. GETPOINT PointName

Returns the saved position of the point name specified. The point's motor step coordinates are returned in X, Y, Z order.

Example:

Command: GETPOINT Position1<13><10>
Response: 2148,-268,15874<13><10>

17.   GETPOS
    Returns the current motor step position of the head in X, Y, Z order.

    Example:

    Command: GETPOS<13><10>
    Response: 2148,-268,15874<13><10>

18.   GETPUMPTYPE
    Returns the type of pump drive ("PSD/2" or "PSD/4") in a SOLO with a 'D' type
syringe.

    Example:

    Command: GETPUMPTYPE<13><10>
    Response: PSD/4<13><10>

19.   GETSHUCKDEPTH
    Returns the number of steps a MultiTip pipette head will travel beyond the 'syringe
    bottom' when shucking disposable pipette tips.

20.   GETSIMULATEPUMP
    Returns the current state of the pump. '0' means the pump is active, '1' means the
    pump is in simulated mode.

21.   GETSKEW Position#
    Returns the offset per mm of travel in both X-axis and Y-axis directions that the plate
    nest at Position$x$ is out of alignment with that axis. The two factors are returned as
    'dX,dY'. The SOLO uses these to adjust the calculated position of the center of a
    well in a plate at Position$x$.

    Example:

    Command: GETSKEW 3<13><10>
    Response: 0.00234,0.01658<13><10>

22.   GETSPEEDS
    Returns the assigned maximum speed for each motor. The speeds are listed X, Y, Z.

    Example:

    Command: GETSPEEDS<13><10>
    Response: 20000, 20000, 50000<13><10>

23. GETSTEPSMM
Returns the number of motor steps required to move 1 mm for each axis, X, Y and
Z in that order.

Example:

Command: GETSTEPSMM<13><10>
Response: 43.225,46.366,315.05<13><10>

24. GETSYRBOTTOM ('P' configuration ONLY)
Returns the position in motor steps of the syringe's bottom of stroke.

25. GETSYRCOUNT
Returns the number of syringes on the SOLO (meaningful in 'D' configuration
only). Default value is 1.

26. GETSYRCURRENT ('P' configuration ONLY)
Returns the existing current setting, 0 – 100, for the syringe drive motor, as a percent
of maximum.

27. GETSYRLIMITS ('P' configuration ONLY)
Returns the stroke limit in motor steps for a full syringe stroke in order:
Bottom, Top.

Example:

Command: GETSYRLIMITS<13><10>
Response: 4160,250<13><10>

28. GETSYRPOS [Syringe(syringe ID letter)]
Returns the current position of the syringe in motor steps. Syringe letter is
optional, and defaults to "a".

Example:

Command: GETSYRPOS a<13><10>
Response: 1206<13><10>

29. GETSYRTYPE
Returns the type of syringe configuration:
                 'P' for Pipettor only (Ivek-type)
                 'D' for pipettor/Dispenser (Hamilton-type)

30.   GETSYRVOLUME [Syringe(syringe ID letter)]
       Returns the full stroke volume of the syringe in uL.

           Example:

           Command: GETSYRVOLUME a<13><10>
           Response: 125<13><10>

31.   GETTIP Position#, PointName, [TipBoxHeight], [NumTips]
       Causes the pipettor to pickup a disposable tip at the indicated position. Returns a 1 or
       0 (text) indicating a successful or failed tip pickup. The optional argument,
       TipBoxHeight, is the height (mm) of the body of the tip box containing the disposable
       tips. This is the Z-axis height of the pickup point. The optional argument,
       NumTips, accepts a number from 1 to 12 ('P' type syringe only) which determines
       the Z-axis current and speed used during this action. The value of this argument is 1
       by default.

           Example:

           Command: GETTIP 1, Position1, [TipBoxHeight], [2]<13><10>
           Response: 1<13><10>

32.   GETTIPLIMITS
       Returns the low limit and high limit (in mm) around the commanded tip pickup
       position (see GETTIP) that indicate a successful tip pickup. Exceeding the lower
       limit indicates an empty tip well, exceeding the high limit indicates jamming
       on a tip's rim, either of which result in a failed pickup (GETTIP returns a 0).

           Example:

           Command: GETTIPLIMITS<13><10>
           Response: 5,15<13><10>

33.   GETTRAVELHEIGHT
       Returns the Z-axis coordinate in motor steps that is used when moving between
       positions.

           Example:

           Command: GETTRAVELHEIGHT<13><10>
           Response: -200<13><10>

34.   GETVALVEPORT [Syringe(syringe ID letter)] ('D' configuration ONLY)
       Returns the most recently selected valve port for connection to the Source
       reservoir. Syringe letter is optional, and defaults to "a".
35.   GETVALVETYPE [Syringe(syringe ID letter)] ('D' configuration ONLY)
       Returns the type of valve (2 to 7), as follows:
                       2: 8 ports, 45 deg apart

3: 6 ports, 60 deg apart
4: 3 ports, 90 deg apart
5: 2 ports, 180 deg apart
6: 2 ports, 90 deg apart
7: 4 ports, 90 deg apart

Syringe letter is optional, and defaults to "a".

36.   GETZCURRENT
Returns the assigned maximum current as a percentage for the Z-axis motor.

Example:

Command: GETZCURRENT<13><10>
Response: 20<13><10>

37.   HERE PointName
Saves the current robot position with the indicated point name. The name cannot
contain spaces or non-printing characters.

Example:

Command: HERE Position1<13><10>
Response: 0000 Success<13><10>

38.   HOME
Homes all motors, including the syringe, and auto-zeros them. When homing
the Z axis, the Z axis finishes by moving to its upper limit (see SETLIMITS).
For both 'P' and 'D' syringe types, the syringe piston homes at the top of its stroke.

Example:

Command: HOME<13><10>
Response: 0000 Success<13><10>

39.   HOME Axis
Homes the motor of the indicated axis (X, Y, Z or P) and auto-zeros it. Then,
if homing the Z axis, moves the Z axis to its upper motion limit.

Example:

Command: HOME P<13><10>
Response: 0000 Success<13><10>

40.   JOG Axis, Distance
Moves the specified Axis (X,Y,Z) the indicated number millimeters. If the distance
exceeds one of that axis' limits, the axis will travel to the limit, and no error will be
issued. Positive values for 'X' are to the user's right, for 'Y' are toward the user, and
for 'Z' are downward.

Example:

Command:	JOG X,500<13><10>
Response:	0000 Success<13><10>

41.   LIMP State
   Turns motor holding power On (1) or Off (0) to all 3 robot axes.

Example:

Command:	LIMP 0<13><10>
Response:	0000 Success<13><10>

42.   LISTPOINTS
      Returns a numbered list of the points saved in the robot's controller. Each line of
the list has the format: #: Name, X, Y, Z. The text End of List will be sent to indicate the
                                              end of the list.

Example:

Command:	LISTPOINTS<13><10>
Response:	1: Position1, 2148, -349, -25491<13><10>
	2: Position2, 3187, -496, -15451<13><10>
	End of List<13><10>

43.   LOADPOINT PointName, X, Y, Z
   Saves the indicated X, Y, and Z values (in steps) under the specified point name.

Example:

Command:	LOADPOINT Position1, 2148, -349, 20491<13><10>
Response:	0000 Success<13><10>

44.   MIX Volume(uL), Speed, #Cycles, Starting Action('A' or 'D') [, Syringe Letter]
Causes the syringe to stroke in/out starting with either an Aspirate ('A') or a
Dispense('D') action, each stroke having the Volume input here at a Speed as a
percent of full (100%) stroke speed.

Example:

Command: MIX 50,25,3,'A',b<13><10>
Response: 0000 Success<13><10>

45.   MOVE PointName
Moves the head to the saved position indicated by PointName, moving the 'X' and
'Y' axes first, followed by the 'Z' axis.

Example:

Command: MOVE Position1<13><10>
Response: 0000 Success<13><10>

46.   MOVE_ABS Axis, Position
Moves the indicated axis (X, Y, Z) to the absolute position indicated in steps.

Example:

Command: MOVE_ABS Z,510<13><10>
Response: 0000 Success<13><10>

47.   MOVE_X PointName
Moves only the X-axis to the position saved in with the indicated point name.

Example:

Command: MOVE_X Position1<13><10>
Response: 0000 Success<13><10>

48.   MOVE_Y PointName
Moves only the Y-axis to the position saved in with the indicated point name.

Example:

Command: MOVE_Y Position1<13><10>
Response: 0000 Success<13><10>

49. MOVE_Z PointName
Moves only the Z-axis to the position saved in with the indicated point name.

Example:

Command: MOVE_Z Position1<13><10>
Response: 0000 Success<13><10>

50. PRIME [Volume(uL)], [Speed(%)], [Syringe ID letter] ('D'
configuration ONLY)
All arguments are optional. The syringe will operate at the speed given (100 is
the default) until the specified volume is moved from the currently selected reservoir
toward the tip. If no, or 0, Volume is specified, the syringe will continuously
move fluid from the currently selected reservoir into the tip, filling the line, and
requiring a "HALT" command to stop the process. If a negative value is given for
Volume, the positive integer of that value will be the number of syringe strokes to be
executed, with the first stroke just bringing the syringe to the top of its stroke. If
Syringe ID is omitted, or if a syringe ID letter above 'j' is used, ALL syringes will be
operated together. See EVACUATE.

Example:

Command: PRIME 1000,25,b<13><10>
Response: 0000 Success<13><10>

51. READINP InputNum
Returns the state of input 'InputNum', which is a number 1 – 72. Returns a 1 if the
input is ON, 0 if OFF. Inputs 1 – 56 are read from the Z-world board, above 56 are
inputs to the M-drives.

Example:

Command: READINP 6<13><10>
Response: 1<13><10>

52.   SEEKLEVEL [Z_Speed (1 – 100%)],[Syringe Speed (1-100%)]
Moves the Z-axis downward as the syringe dispenses air, causing a pressure wave to back up when a fluid surface is encountered, triggering a sensor and halting the Z-axis and syringe piston. The Z_Speed and Syringe Speed values should set so that the syringe continues to move during the entire Z-axis stroke. If they are not used, default values of 50% are used for each. The command returns the word "LIQUID" or "DRY" at the end of the movement, plus the Z-axis coordinate and the syringe piston motion coordinate at the halt position.

Example:

Command: SEEKLEVEL 30,10 6<13><10>
Response: LIQUID,21345,2078<13><10>

53.   SET SourcePoint, DestinationPoint
Copies the saved position coordinates from the indicated source point name into the position indicated by the destination point name. The destination point does not need to exist beforehand.

Example:

Command: SET Position1, TEMP<13><10>
Response: 0000 Success<13><10>

54.   SETDECKHEIGHT Position#, DeckHeight
This establishes the distance (mm) of the surface of the plate nests below the shoulder of the disposable tip mandrel when it is at the low Z-axis limit above plate nest Position*x*. If Position# is set to '-1', then all plate nest deck heights will be set to this number. Should be set to 0 for a SOLO with a fixed (washable) tip.

Example:

Command: SETDECKHEIGHT 35.5<13><10>
Response: 0000 Success<13><10>

55.   SETDISPTIPCURRENT
Sets the LOW and HIGH Z-Axis running current range (as a % of 100) to use when performing the GETTIP command. The current is adjusted linearly between the LOW and HIGH values in proportion to how many tips are to be retrieved (1 to 12).

Example:

Command: SETDISPTIPCURRENT 12,40<13><10>
Response: 0000 Success<13><10>

56.   SETDISPTIPSPEED
Sets the LOW and HIGH Z-Axis velocity range to use when performing the GETTIP command. The speed is adjusted linearly in inverse proportion between the LOW and HIGH values in proportion to how many tips are to be retrieved (12 to 1).

Example:

Command: SETDISPTIPSPEED 4000,8000<13><10>
Response: 0000 Success<13><10>

57.   SETFULLSTROKE
Sets the value of the number of stepper motor steps per full stroke of the syringe. The same value is used for every syringe in a multi-syringe equipped SOLO.

Example:

Command: SETFULLSTROKE 2000<13><10>
Response: 0000 Success<13><10>

58.   SETIPADDR XXX.XXX.XXX.XXX
Assigns the indicated IP address to the controller. The controller will immediately disconnect all TCP/IP connections and begin using its new IP address. This will cause an immediate loss of communications if this command is sent from a TCP/IP connection.

Example:

Command: SETIPADDR 192.168.1.2<13><10>
Response: 0000 Success<13><10>

59.   SETLAYOUT Layout
Sets the SOLO's layout, using a value of 'L' (landscape) or 'P' (portrait). 'L' is
the default. If the SOLO has other than 6 plate nest positions, this may be set by
immediately following the "L" or "P" with the number of plate nests (up to 9). If this
is omitted, 6 nests are assumed. See GETLAYOUT.

Example:

Command: SETLAYOUT P5<13><10>
Response: 0000 Success<13><10>

60.   SETLEVELSENSING State ('1' or '0')
Activates the level sensing feature of a SOLO equipped with level-sensing hardware.

Example:

Command: SETLEVELSENSING 1<13><10>
Response: 0000 Success<13><10>

61.   SETLIMITS Xmin, Xmax, [Ymin, Ymax], [Zmin, Zmax]
Sets the limits of motion for each axis.

Example:

Command: SETLIMITS -2700,13600,-1600,9700,-5020,21020<13><10>
Response: 0000 Success<13><10>

62.   SETPUMPTYPE
Sets the type of pump drive ("PSD/2" or "PSD/4") in a SOLO with a 'D' type
syringe.

Example:

Command: SETPUMPTYPE PSD/2<13><10>
Response: 0000 Success <13><10>

63.   SETSHUCKDEPTH Steps
Sets the number of steps past the syringe "bottom" which the MultiTip syringe will
move when shucking disposable tips.

Example:

Command: SETSHUCKDEPTH 1500<13><10>
Response: 0000 Success<13><10>

64.   SETSIMULATEPUMP State ('0' or '1')
Allows the user to treat the syringe pump as a real pump ('0') or to operate in
simulated mode, ignoring pump commands ('1').

Example:

Command:	SETSIMULATEPUMP 1<13><10>
Response:	0000 Success<13><10>

65.   SETSKEW Position#,dX,dY
Sets the factor, in mm per mm of axis travel, by which the plate nest at Position*x* is out of alignment with the X-axis (dX) and the Y-axis (dY).

Example:

Command:	SETSKEW 3,0.00234,0.0135<13><10>
Response:	0000 Success<13><10>

66.   SETSPEEDS Xspeed, Yspeed, Zspeed
Sets the assigned maximum speed for each axis.

Example:

Command:	SETSPEEDS 50000, 50000, 100000<13><10>
Response:	0000 Success<13><10>

67.   SETSYRBOTTOM ('P' configuration ONLY)
Sets the position in motor steps of the syringe's bottom of stroke. The top of stroke (see GETSYRLIMITS) is automatically based upon the hard-coded syringe stroke length.

Example:

Command:	SETSYRBOTTOM 4150<13><10>
Response:	0000 Success<13><10>

68.   SETSYRCURRENT Spercent ('P' configuration ONLY)
Sets the current level of the syringe motor to increase or reduce its force; expressed as a percent value in the range 0 – 100. This is reset at power-on.

Example:

Command:	SETSYRCURRENT 50<13><10>
Response:	0000 Success<13><10>

69.   SETSYRTYPE Type
Sets the configuration of the syringe:
'P' for Pipettor only (Ivek-type)
'D' for pipettor/Dispenser (Hamilton-type)

Example:

Command: SETSYRTYPE P<13><10>
                             Response: 0000 Success<13><10>

70.   SETSYRVOLUME Volume, [Syringe(syringe ID letter)]
         Sets the full stroke volume of the syringe in uL. Syringe letter is optional, and defaults to "a".

Example:

Command: SETSYRVOLUME 125<13><10>
Response: 0000 Success<13><10>

71.   SETTIPLIMITS Lower, Upper
Sets the distances (mm) above and below the defined height of the tip box when the tip mandrel shoulder (for 'P' type syringes), or the shucking bar (for multi-tip syringes), is at the tip box height) which indicates either a jammed mandrel tip (the 'Upper' number) or an empty tip position (the 'Lower' number). Reaching 'Lower' figure indicates that the mandrel passed the normal tip press position, indicating an empty tip box location, while stopping at the 'Upper' indicates that the mandrel has jammed on a tip rim and didn't secure a tip. Both are positive numbers. The Lower limit is usually set to 0, while the Upper limit should be roughly 1mm less than the length of the mandrel nib.

Example:

Command: SETTIPLIMITS 0,8<13><10>
Response: 0000 Success<13><10>

72.   SETTRAVELHEIGHT Zmm
Sets the height (in mm) below the Z-axis upper limit position for traveling between positions. Usually set to 1 mm.

Example:

Command: SETTRAVELHEIGHT 1<13><10>
Response: 0000 Success<13><10>

73. SETVALVEPORT PortNum, [Syringe(syringe ID letter)] ('D' configuration ONLY)
Sets the current valve position, connecting the needle (always port 1) to the selected reservoir (ports 2 – 7, depending upon valve type). This will be the port used for a subsequent ASPRATE, DISPENSE, EVACUATE or PRIME commands. Syringe letter is optional, and defaults to "a".

Example:

Command: SETVALVEPORT 5<13><10>
Response: 0000 Success<13><10>

74. SETVALVETYPE Type, [Syringe(syringe ID letter)] ('D' configuration ONLY)
Sets the type of valve (2 to 7) currently mounted on the syringe pump body, as follows:
> 2: 8 ports, 45 deg apart
> 3: 6 ports, 60 deg apart
> 4: 3 ports, 90 deg apart
> 5: 2 ports, 180 deg apart
> 6: 2 ports, 90 deg apart
> 7: 4 ports, 90 deg apart

Syringe letter is optional, and defaults to "a".

Example:

Command: SETVALVETYPE 2<13><10>
Response: 0000 Success<13><10>

75. SETZCURRENT Zpercent
Sets the current level of the Z-axis motor to increase or reduce its moving/holding force; expressed as a percent value in the range 0 – 100.

Example:

Command: SETZCURRENT 50<13><10>
                  Response: 0000 Success<13><10>

76. SHIFT PointName,Xmm,Ymm,Zmm
Adds the indicated distances (mm) to the saved position of the position 'PointName'. The result becomes the new saved position of that point.

Example:

Command: SHIFT TEMP,9,-18,0<13><10>
Response: 0000 Success<13><10>

77. SHUCKTIP PointName
Moves the tip to the indicated position name, which should be inside the tip stripping bracket. This command first moves to a location 20mm forward of the position (in the

'Y' direction), then moves horizontally to it. Lastly, the arm moves to the 'Z' travel height to strip off the tip. A permanent, non-deletable position called "TipDisposal" would normally be used for this, but any position name can be designated.

Example:

Command: SHUCKTIP TipDisposal<13><10>
Response: 0000 Success<13><10>

78.   SPEED Percentage
Set all current X,Y,Z motor speeds to the indicated percentage of maximum speed.

Example:

Command: SPEED 50<13><10>
Response: 0000 Success<13><10>

79.   STATUS [Axis]
If the optional 'Axis' argument is not provided, returns a 1 if all motors (including the syringe) are homed, returns 0 if any or all are not homed. If the 'Axis' argument is given ('X', 'Y', 'Z', or 'P'), will return a 1 if that axis is homed, 0 if not.

Example:

Command: STATUS X<13><10>
Response: 1<13><10>

80.   SYRINGE ('D' configuration ONLY)
Places the user's computer in "terminal" mode communicating directly with the syringe pump and valve. Entered characters are sent directly to the pump/valve controller. The user can exit terminal mode by typing the 'cntl Z' character.

Example:

Command: SYRINGE<13><10>
Response: Type ^Z to Quit<13><10>

81.   TERMINAL
Puts the SOLO into terminal mode. This mode will allow commands to be sent directly to the motors or syringes. The user can exit terminal mode by typing the 'cntl Z' character.

Example:

Command: TERMINAL<13><10>
Response: Type ^Z to Quit<13><10>

82.   TOUCHTIP PointName,X_shift,Y_shift,Z_shift,[Speed]
Will move the tip to a location X_shift, Y_shift and Z_shift (all in mm) from the position given by 'PointName', then –X_shift and –Y_shift from the taught location. The value of Z_shift is negative for an upwards shift. Speed is optional, and is a percent of full speed (defaults to last speed command value).

Example:

Command: TOUCHTIP Position1,4,0,2<13><10>
Response: 0000 Success<13><10>

83.   VERSION
Returns the current firmware version.

Example:

Command: VERSION<13><10>
Response: Hudson SOLO v3.00<13><10>

84.   WRITEOUT OutputNum, State
Sets the state of output 'OutputNum' (1 – 72) to the value of 'State' (1 to turn the output ON, 0 to turn it OFF). Inputs 1 – 56 are on the Z-world board, above 56 are outputs on the M-drives.

Example:

Command: WRITEOUT 58,1 6<13><10>
Response: 0000 Success<13><10>